

The AMSAT Journal

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Volume 17, No. 3

May / June, 1994

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Dayton Hamvention '94 Best Ever For AMSAT-NA

The 1994 Dayton Hamvention is now history, and AMSAT-North America's (AMSAT-NA) participation at this year's gathering was nothing short of a record breaker from a number of standpoints. "While all the numbers aren't in yet, we

now believe this will be our best year ever for AMSAT at Dayton," said Bill Tynan (W3XO) AMSAT-NA President. He went on to express his sincere thanks for the very long hours, lost sleep and hard work put

Continued on Page 4



Astronauts Tony England WØ0RE and Steve Nagel W4RAW with Roy Neal K6DUE at Dayton

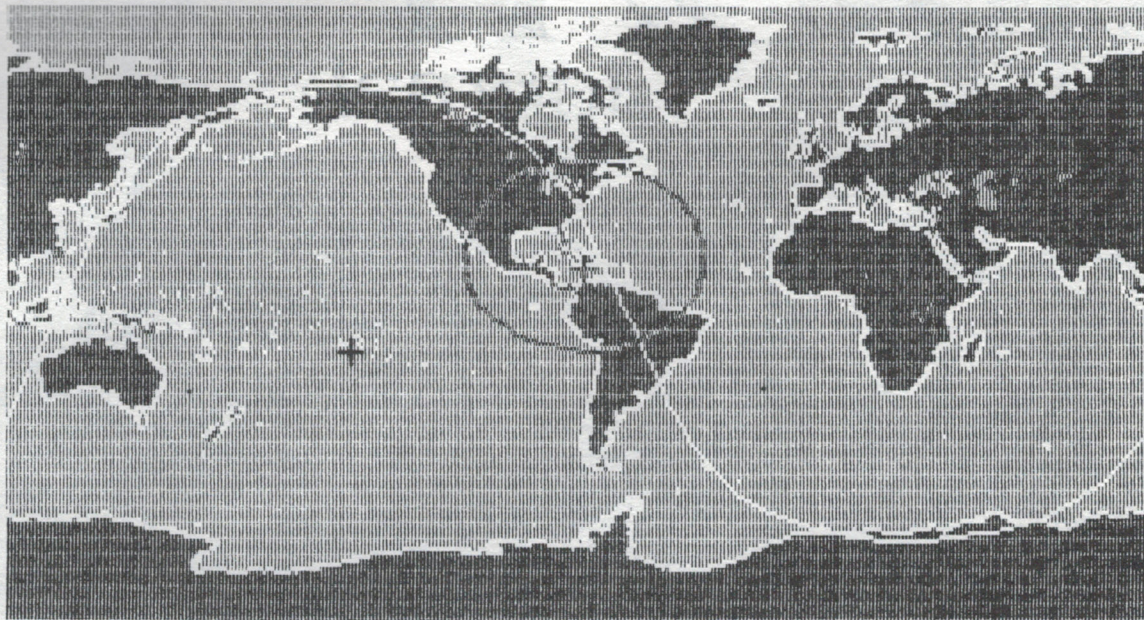
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The AMSAT Journal (ISSN:1047-3076) is published bi-monthly (Jan, Mar, May, July, Sept, Nov) by AMSAT-NA, 850 Sligo Avenue, Silver Spring, MD 20910-4703. Telephone: 301-589-6062. Second Class postage paid at Silver Spring, MD and additional mailing offices. Postmaster: send address changes to The AMSAT Journal, 850 Sligo Avenue, Silver Spring, MD 20910-4703.

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Apogee View

Protecting Our Most Precious Resource

by Bill Tynan, W3XO

Amateur Radio in general, and the amateur satellite community, in particular, have one resource, without which they would cease to exist. That resource is the radio spectrum.

We must always be vigilant to any threats that might diminish our access to the spectrum. Such threats rear their heads frequently, and we must be ready to respond. In this country, the ARRL does a credible job speaking for the overall interests of Amateur Radio. On the worldwide scale, the IARU has been very effective in preserving amateur frequencies. No, they don't always prevail, but they are successful in a large percentage of cases.

The spectrum preservation efforts of the ARRL and IARU do include those bands of frequencies specified for the Amateur Satellite Service. This is because they value the contribution that the amateur space community has made, and will make, to Amateur Radio; and because all of the segments allocated to the Amateur Satellite Service are contained within the bands allocated to the Amateur Service. Despite this commonality of allocation, and identity of the users (we licensed amateurs), the Amateur Service and the Amateur Satellite Service are defined as separate radio services by ITU. Although the two services use common frequencies and generally share the same objectives, the amateur space community does have certain unique needs which are best addressed by groups intimately acquainted with the specific needs of that facet of Amateur Radio. That is why AMSAT feels compelled to respond to proposals which might threaten our access to Amateur Satellite Service spectrum. However, our participation in such processes does not mean that our responses are generated without consulting ARRL and IARU. Such consultation is, in fact, vital to presenting a united front and avoiding conflicting statements.

A situation requiring just such an AMSAT response, along with close coordination with ARRL, recently presented itself.

It was prompted by a notice from the National Telecommunications and Information Administration (NTIA), an agency within the U.S. Department of Commerce charged with the administration of Government spectrum; in the same manner as the FCC administers non-Government spectrum. The NTIA notice was in response to a Congressional mandate enacted as part of the Omnibus Budget Reconciliation Act of 1993, specifically Title VI, which ordered the release of major blocks of Government frequencies to the private sector.

Unfortunately for the Amateur Service and the Amateur Satellite Service, some of the "Government" frequencies, marked for release to the private sector, are also Amateur Service and Amateur Satellite Service bands. As everyone should be aware, all of our bands from 420 MHz to 10.5 GHz are SHARED with other services, mostly Government radiolocation (RADAR). Despite our role as a "Secondary" user, this sharing arrangement has worked well for nearly a half century. Since Government's principal use of these bands has been for radars, mostly operating at sea or on foreign soil, they have seldom bothered us; and we certainly haven't bothered them. There have been some exceptions when high power radars have been constructed in various parts of the U.S. The 70 cm PAVE PAWS installations are a specific example. Some radar interference to amateur satellites has also been noted, but even that has been generally manageable. So, this sharing has worked well since just after World War II. But times are changing. The end of the Cold War has lessened the need for so much spectrum being devoted to Government use - or so many politicians believe. In addition, the effort to reduce the Federal deficit, has given officials and Congress members the idea that the Government can make money by "selling" (auctioning) spectrum to private interests. Hence the NTIA notice.

Following the Congressional mandate, the notice proposes to release to the private

sector at least 200 MHz of spectrum below 5 GHz. Of that, 100 MHz is to be below 3 GHz. Of the 200 MHz, 50 MHz is to be released "immediately" and the other 150 MHz over the next 15 years. I won't list those affected frequencies which are not allocated to the Amateur Service. I assure you that most of the proposed reallocations do not involve amateur frequencies. So, no one is specifically gunning for us. Nevertheless, we are affected and, half of the spectrum slated for immediate release does involve Amateur frequencies.

Specifically, the NTIA notice proposes to reallocate from Government to private use the following segments in accordance with the noted schedule:

2300 to 2310 MHz	January 1996
2390 to 2400 MHz	Immediately
2402 to 2417 MHz	Immediately

Note that 2400 to 2402 and 2417 to 2450 are left as is.

NTIA omitted 2400 to 2402 MHz because of its known amateur satellite use. It is occupied by several currently operating amateur satellites including AO-13, DOVE and UO-11. One of Phase 3D's major downlinks will be in this band. NTIA is to be applauded for proposing to preserve the present status of this segment. However, unless it is disturbed by a major loss of frequencies, this part of the spectrum is certain to experience a significant increase in use by amateur satellites over the next 10 to 20 years. This is necessitated by the ever increasing crowding on the 2 meter and 70 cm satellite bands. The 23 cm satellite band (1260 to 1270 MHz) is available for uplinks only.

With this background, I think you can more fully appreciate the comments, presented elsewhere in this issue, which AMSAT filed in response to the NTIA inquiry. They represent the combined work of Perry Klein W3PK, Jan King W3GEY, Ray Soifer W2RS and this writer. We were aided by some very thoughtful and helpful suggestions from Paul Rinaldo W4RI of ARRL's Washington office.

But, the fight is just beginning. In anticipation of a reallocation to non-Government use, the FCC has already released a notice of its own. It deals with how this "newfound" spectrum is to be utilized once made available for their allocation to non-

Government users. One might conclude that the Amateur Service and the Amateur Satellite Service can continue to share, as Secondary users, with whomever the new Primary occupants are; just as we have with Government for almost fifty years. But, if a company, or consortium, has paid Billions of Dollars for frequencies; is it going to be willing to share its bounty with hams? I believe the chance is slim at best. So our next job, in cooperation with ARRL, is to

convince the FCC that the Amateur Service and the Amateur Satellite Service must retain a reasonable amount of space in the 2 GHz region for satellite communication as well as other amateur work such as weak signal operation, ATV and high speed data transmission.

The AMSAT Journal will continue to keep you advised on further developments.

Hamvention '94

Continued from page 1

forth by the many Dayton AMSAT booth volunteers, forum speakers and contributors. In addition, Bill expressed his particular pleasure that the success at this year's Hamvention also coincided with AMSAT's 25th anniversary celebration. Without question, the highlight of this year's Hamvention activity was a forum honoring the 10th anniversary of SAREX activity aboard the NASA Space Shuttle. Roy Neal (K6DUE) moderated the forum and was joined on the podium by NASA Shuttle Astronauts Tony England (WØORE) and Steve Nagel (N5RAW) along with several other members of the SAREX working group. Also joining the group by live telephone patch were Astronauts Jay Apt (N5QWL) at the Johnson Space Flight Center in Houston and Astronaut Ron Parise (WA4SIR) at the Goddard Space Flight Center in Greenbelt, Maryland. In addition, a surprisingly clear telephone patch was successfully completed to Astronaut Ken Cameron (KB5AWP) in Star City, Russia. Ken is now training there for an upcoming joint NASA/Soyuz mission to the Russian Space Station MIR. All the astronauts shared their on-orbit experiences with ham radio and answered several questions from the gathering of Hamvention attendees. A number of students who have contacted the Shuttle via Amateur Radio in the past were also present at the forum and gave their own first hand impressions of their activities. Local TV coverage from all three Dayton commercial television stations highlighted the NASA astronauts speaking to the standing-room-only crowd of nearly 500 present at the event.

Other AMSAT activities at this year's Hamvention included a beginner's forum hosted by Keith Baker (KB1SF) along with a new PACSAT forum hosted by John Hansen (WAØPTV). Ed Krome (KA9LNV) highlighted the simplicity of Mode-S in a

forum dedicated exclusively to that activity. Dick Jansson (WD4FAB) AMSAT-NA's VP for Engineering, was also on the program and brought Hamvention attendees up to speed on the latest developments with Phase 3D. In addition, Ron Broadbent (G3AAJ) the Honorable Secretary of AMSAT-UK, gave his organization's perspective on the Phase 3D project. Ron also announced to the group that a \$100,000 contribution from AMSAT-UK was recently made to the Phase 3D project specifically for the purchase of flight batteries for the new spacecraft.

Unfortunately, two days of steady rain on Friday and Saturday followed by extremely cold weather on Sunday kept most of the crowd indoors. Despite the bad weather, however, well over 200 people stopped by the booth to initially join or renew their memberships in AMSAT-NA.

New items at this year's AMSAT booth included two new software programs and a number of other items. Joe Holman (KA7LDN) unveiled AMSAT-NA's first ever Microsoft Windows-based satellite tracking program called WinSat. In addition, a new Microsoft Windows-based PB/PG packet software package called WISP written by Chris Jackson (ZL2TPO), was premiered at the booth. Needless to say, both of these new AMSAT software packages were in great demand by Hamvention attendees.

Other new items included an AMSAT 25th Anniversary patch and decal. Also, several new books were premiered at the booth, including the fourth and latest edition of "How to Use the Amateur Radio Satellites" by Keith Baker (KB1SF) and a newly revised "AMSAT-NA Digital Satellite Guide" edited by Gould Smith (WA4SXM).

UNAMSAT-1 Experiment Module TSFR

by David Liberman, XE1TU

UNAMSAT-1 is a microsat built by the Universidad Nacional Autonoma de Mexico, UNAM and the TSFR or Module 4 is occupied by the hardware required to perform the science experiment proposed for this mission. This paper gives a description of this hardware as well as a more detailed description of the experiment.

Meteors have been in the field of inter-

est of scientists and radio amateurs for a long time. Scientists are concerned with meteors because they represent the matter in the Universe that doesn't necessarily emit any type of radiation. For this reason, they are considered part of the "Dark Matter" that composes the Universe.

In a sense, some of them could be the only messengers coming from outside the

Solar System. Of course, many come from inside the Solar System. From earth, the escape velocity of the Solar System is close to 72 km/h, and that should also be the velocity of an object falling to earth and coming from outside the Solar System. This is the parameter we intend to measure with UNAMSAT-1.

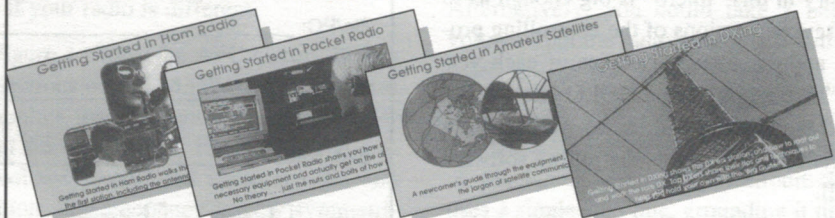
We know that when a meteorite enters the atmosphere it will suffer great ionization due to the friction with the molecules of the atmosphere. It has been reported that there are basically two types of ionization produced. One is from molecules of the meteor itself that will become part of the trail left behind by the meteor and the other, probably due to a very strong emission of ultra-violet light by the body of the meteor, the ionization of atmosphere molecules, which recombines very fast and seems to be present only in the vicinity of the meteor itself.

A radio wave bounced from the trail (named the "trail-echo") can give, through its intensity, an idea of the kinetic energy of the meteor. The wave bounced from the ions surrounding the meteor (named "head echo") will produce a Doppler frequency displacement due to the velocity of the meteor relative to the satellite.

The instrumental requirements are a pulse transmitter, a receiver with the capability of tuning plus or minus the expected Doppler shift of the echo, a control circuit and a power conditioner for the transmitter, plus the corresponding AART. Let me describe each of these devices.

The power required is calculated considering the path loss from the satellite to the meteor trail. Then an analysis of the scattering of the incident wave is done, but only the back-scatter component is considered, to calculate the power returning to the satellite. Again, a path loss from the fraction of power back-scattered in the direction and at the distance of the satellite is accounted for. This yields a power requirement at 40.997 MHz of 70 watts peak. We decided to add a safety factor and the transmitter was built for 70 W RMS.

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The parameters used to calculate the back-scattering considered that we should be able to get echoes from meteors producing 10^{12} ions per meter of trajectory as a minimum. This number of ions is also the limit to consider the trail under-dense or over-dense. The over-dense trail has more than 10^{12} ions per meter and can be considered a perfect electrical conductor. So we calculated the total loss of the signal to allow us to see the over-dense meteors. In general, there is no relation between the mass of the meteor and its kinetic energy. A meteor of 1 gram at a high velocity will leave a trail equal in ionization density as a bigger meteor with much less velocity.

The efficiency of the transmitter had to be as large as possible to avoid generating too much heat. Jan King advised that we should try to use a Mode F final amplifier.

We built an exciter frequency controlled by crystal with 220 mW and the transmitter was built with only two transistors. The measured power is 70 W RMS and the efficiency from D.C. to R.F. is 92%. A large amount of testing has been performed and the transmitter looks very stable and "well behaved".

The receiver is based on a suggestion made by Tom Clark, W3IWI, and is basically a GasFet preamplifier, a double balanced mixer, a bandpass filter, an I.F. amplifier, a phasing network producing +90 degrees and -90 degrees to a summing amplifier, all of this for each of the sidebands. The mixer uses a sample of the crystal oscillator of the exciter, so no corrections are required to obtain the true Doppler shift.

The control circuit for this module is based in the 68HC805B6. It controls the pulse duration by reading 4 bits in the AART for low duration and 4 bits for the high duration. The duration can be controlled between 1 msec and 16 msec and the pulse repetition rate from 1 to 16 sec between pulses. The same microprocessor has an A/D converter that digitizes the echo and has a serial output to send this information to the main CPU on the satellite for further processing.

The module has several thermistors that will allow us to know, via telemetry, the temperature of many points in the module. There is also a watch-dog timer made with a counter and a gate ("and") that will reset

the microprocessor in case the pulse tries to stay high for more than 16 msec.

The transmitter and the receiver are connected to the same antenna through a hybrid circuit with more than 26 dB isolation. The receiver uses the same signal sent to key the transmitter to blank its preamplifier and the I.F. during transmission to avoid overloading.

The antenna's supports were modified to allow for the additional antenna for 41 MHz. In Module 1 of the microsat, we have an antenna coupler and a coaxial line of $\frac{1}{2}$ wavelength to connect the other half of the canted dipole.

The HC805 can be reprogrammed from the ground by using one of the HDLC lines going to one of the PSK transmitters. The memory in this "micro" is big enough as to hold several versions of the controlling program and even several copies of each version. Through the same HDLC line we can record the starting address so we can use a different version of the controlling software at will.

The digitized echo (64 bytes) will be sent to the main CPU where further processing will take place, like a Fast Fourier Transform, and comparisons between consecutive echoes made to determine if there has been a Doppler shift. If the shift is within certain limits, it will be put in a file that will be retrievable by all amateur users, so they will also be able to determine the velocity of the meteor. Each meteor will be placed in a different file along with the time information that will allow us to know when and where the event took place.

Finally the power supply. It represented a good engineering problem as the transmitter will require 10 amps on the 10 volt bus line when transmitting the pulse. Due to the duty cycle, we decided to build a switching power supply that will charge 16 tantalum capacitors of 330 uF to a voltage of 40V. requiring only 50 mA for a very short time (about 0.5 sec). This way the 10 V bus line doesn't even know that the satellite is sending 70W RMS pulses.

Another interesting engineering problem was to make it all fit in the TSFR, but we succeeded with no small effort and it looks very nice. It has been tested many times and we are very confident that it should perform in space according to expectations.

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Closed Loop Doppler Correction for 9600 Baud Satellites

by James A. Sanford, WB4GCS

Users of DSP modems on the digital birds have enjoyed the automatic Doppler correction in the PSK modes and have wished for the same feature in the 9600 baud FSK modes. Although FSK is more tolerant of frequency error than PSK, the amount of data recovered during a pass can be significantly improved by some sort of automatic Doppler correction — particularly for automated stations.

I use a transverter and an ICOM 751 for 70cm satellite operations and decided to automate the Doppler correction within the radio. It is worth noting that the 751 uses the same FM board as many other ICOM radios, so my solution may work for you, even if your radio is different.

Figure 1 shows the AFC circuit. It uses two sections of an LM339 quad comparator to monitor the discriminator center meter output from the ICOM FM board. The output voltage is centered about 0 volts and variation with frequency is very symmetrical. One comparator section is configured to provide an active output if the discriminator voltage rises above about 0.6V, and

the other provides an active output when the voltage is less than about -0.6V. These values give a total bandwidth of approximately 5.8 KHz. As wide as it sounds, this is more than adequate for 9600 baud FSK operation. The comparator outputs are open collector stages, so pullup resistors will be required if you use a different output circuit. The 10k input resistor provides some input isolation, and the 0.1µF capacitors provide some RF decoupling.

Since the input is centered about 0 volts, the comparators must operate from a dual polarity supply. The MAX 636 (available from Digi-Key) generates the negative voltage with few components and little noise. Alternatively, you could take a negative voltage from the radio's display board; I decided not to risk overload or noise problems.

The AFC output circuit is a consequence of the IC-751's step input circuit. ICOM uses a single step line, grounding it directly to lower frequency. Grounding it through a 680 ohm resistor reduces the current and causes the rig to increase frequency. This

sensitivity to step line current requires the PNP output transistors to switch the step line to ground. Connecting the comparator outputs directly to the step line would cause it to be connected to the -12V rail when a comparator is active. This would draw enough current to cause the radio to step down, despite the 680 ohm resistor.

I was very concerned about noise induced false switching, so the initial design had a 10 Megohm feedback resistor to provide some hysteresis in the comparators. The hysteresis worked, but resulted in overlapping "dead bands", which caused the rig to hunt. Despite the constant stepping up and down, data recovery was satisfactory, but the last digit flicker was annoying. Removing the feedback resistors to eliminate the hysteresis resulted in no conflict between the two comparators, and no problem with noise.

I built the circuit on a small piece of "perf board" and enclosed it in a small metal box outside the radio. I ran an additional wire from the FM board discriminator center output terminal through a ferrite bead to

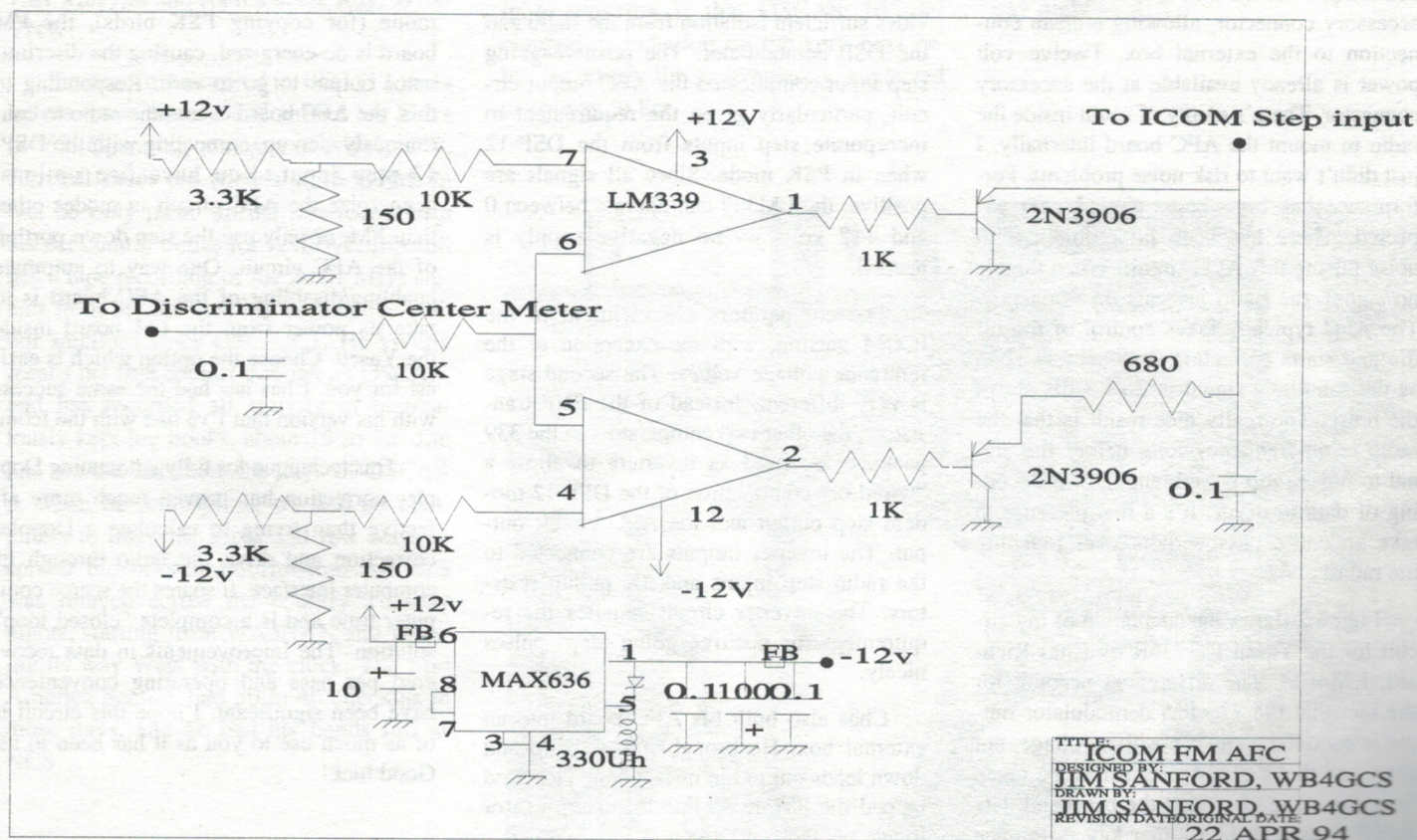


Figure 1

A Visit With WØCY, Elder Statesman of AMSAT HF Nets

by Jim White, WDØE

For just about forever, Jim McKim, WØCY, of Salina, Kansas has been net control of the Mid America Section of the AMSAT 75 meter net. His big signal is always inviting on Tuesday nights, and he nearly always hears my measly 100 watts to a short dipole from Denver. Noting he was right on our route, my wife and I had planned to visit Jim when we drove to Dallas for the 1993 AMSAT Symposium. But we missed the opportunity when scheduling forced us to fly instead. While chatting with John, WØRLC, on a local repeater I discovered he had been Elmered by Jim when he lived in Salina years ago. When I found out John still had relatives in Salina and flew his plane there from time to time, a plan began to form to visit Jim. After a few weeks of syncing schedules, on the bright and clear morning of February 6 we hopped in John's Muskeeter for the trip east. A couple of hours later we were enjoying a most pleasant visit with Jim and John's uncle Roy, WAØVNW.

Jim was first licensed in 1933 (12 years before I was born!), and earned his Extra in '62. Operating almost exclusively CW, Jim still skeds old friends at 45 WPM. In fact he only picks up the mic to perform his net control duties for AMSAT. Jim still has a tape recording of the 20.01 MHz signals from Sputnik and has been active with our satellites since OSCAR 1. He vividly recalls his first contact through an OSCAR, and has recorded all activity in meticulously kept log books, about 75 so far. Jim has run the net since the days of OSCAR 6, when he reminds us, we had no computers to track the birds and few ways to spread the needed information. All data was relayed across the country Tuesday nights, starting from WA3NAN and working its way West with the clock. The Mid America Section had 30 to 40 checkins in those days, and he had his hands full as NCS.

As he showed us around his yard, the reason for his outstanding 75 meter signal became apparent. He feeds 500 watts from an immaculate Loudenboomer amp through about 200 feet of 9913 to a wire that runs 75 feet up beside the tower, then horizontally NE/SW 165 feet to a slightly shorter support. A Corsair II, home brew tuner, and other assorted goodies round out the shack. Jim runs tracking software on a Commodore 64, proving you don't have to have a mega-buck computer to locate the birds.

There's a great article about Jim and OSCARs in the December 1986/January 1987 issue of Air and Space magazine. Jim's eyes sparkled as he related how the lady reporter who visited him was amazed at what he could do through OSCAR 10 from his basement. She took some photos, lots of notes, and went home to write a story well worth digging out of the microfilm archive at your local library. Even more amazing is that OSCAR 10 succumbed to radiation on the very next orbit, an event Jim conveniently neglected to convey to her.

Jim allows that the 75 meter nets aren't as popular as they used to be now that we have computers, internet, packet and more information than we can absorb. But he still gets a dozen or so check-ins every Tuesday night, and information about our birds is just as important to that group as it ever was. Besides, it's a friendly gang on 75, and there's always someone to help or supply an answer.

The weather held clear and sunny as John and I headed back to Denver that afternoon. Our visit was temporarily pushed from my mind as John handed me the controls about 10 minutes out of Salina. But memories of Jim's warm hospitality and walls lined with awards for everything from public service to DXCC came flooding back as I drove home from the airport. Thanks Jim, for your service to ham radio, to AMSAT, for the hundreds you have Elmered, and for your strong and helpful presence on 3840 kHz every Tuesday night.



Jim McKim, WØCY, and the HF station from which he runs the 75 meter AMSAT net.

Operating Satellite Mobile in KL7

by Vick Applegate, WA7DEO
303 Rimrock Way
Missoula, Montana 59802-2314

Fourteen year old Rick Applegate, N7WKS of Missoula, Montana became determined to access amateur satellites during his family's recent vacation through Canada to Alaska undoubtedly to break up the monotony of sitting in a car 5 to 8 hours a day. Rick's first choice was OSCAR 21 in FM mode. This satellite passed over his location ten times per day.

His first attempts at OSCAR 21 utilized a 1/2 wave 2 meter vertical for receiving and a home brew 1/4 wave ground plane for the 435 MHz uplink signal. Several attempts proved it to be a bit marginal. Travelling down the road, the 2-meter satellite downlink signals of OSCAR 21 were easily copied. Unfortunately ground stations could only copy N7WKS's call sign as the satellite passed in and out of the 1/4 wave antenna radiation lobes. Rick suggested that he needed the gain of the 435 yagi brought along for OSCAR 13 operation. So he enlisted his father, WA7DEO, to become the human antenna rotator. Strapping the small 435 MHz yagi to a canoe paddle, the canoe paddle yagi was aimed at arms length to the approximate location of OSCAR 21. Rick commanded "move it around Dad,,,hold it, right there!" Success! The FM mode satellite and super friendly amateurs using it provided consistent contacts from fixed mobile/VY1, VE7 & KL7 along the Cassiar and Alaska highways.

OSCAR 21's predictable and usable passes of 5 to 15 minutes made it great for pulling over, hooking up the gear, making a couple of contacts and then proceeding down the road. Rick used a dual band VHF/UHF hand-held with a small amplifier for 435 FM for the satellite uplink and a mobile 2 meter rig for receiving the satellite downlink.

Rick also made a number of contacts through OSCAR 13. Then there were the contacts that didn't require actually turning on the radios at all. If you want to generate attention in a campground just point upward a couple of 20 element crossed yagis for 435 and 145 MHz from a boat rack on the roof of your car and watch the heads turn. Many people would walk by, some several times, but few would approach the vehicle probably due to the "crazy appearance" though it is sure to attract hams in the area.

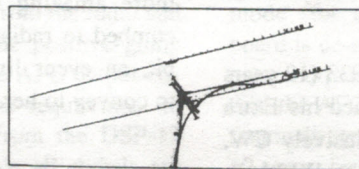
The first contact after setting up the larger arrays at remote lake in Northern British Columbia was with DJ9MJ, Karl. Contact and QSL exchange was made even before the rigs were turned on! It was an eyeball QSO after Karl spotted the yagis pointing

skyward. He was vacationing and camping in the same area. The very next day at another lake campsite 200 miles north, VE7CNQ, Glenn, came over for an eyeball again having spotted the satellite arrays. Guess radios may not be necessary for establishing ham to ham contacts!?



Rick Applegate's mobile OSCAR 13 station attracted a great deal of attention on the road to KL7.

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Umbrellas in the Mist

by James Miller, G3RUH
3 Benny's Way
Coton, Cambridge
CB3 7PS, England
E-mail: g3ruh@amsat.org

I'm going to tell you how to calculate OSCAR-13's spin rate to 6 decimal places. Bored already? OK, suit yourself. Go away and do something more interesting. But do you think I would be wasting your time and mine telling you something this trivial if there wasn't a reason?

So, you have your super-duper OSCAR-13 telemetry decoder [1,5] and your super-duper P3C.EXE [2] or whatever display software, and you wonder if all those darn numbers can be of any further use. Well, here's a simple experiment you can do, that should keep you off the streets for years. I know, because it has me!

Raw Spin Count

One of the numbers in the AO-13 telemetry is the so-called "raw spin count". It comes from the sun sensor system. What happens is that as the satellite is spinning, a photo-diode sensor outputs a pulse once per revolution as the sun flashes by. This pulse is used to synchronize an oscillator that runs at exactly 256x the spin rate. The oscillator drives an 8-bit counter. So the value of this counter at any instant is a measure of the rotational position of the satellite to a resolution of 1/256th of a revolution, about 1.4 degrees.

Now the telemetry data is gathered up and sent down approximately every 27 seconds, so that the instantaneous value is frequently available, together with a time-tag. It follows then, that with a couple of successive angles and time-tags, the satellite spin rate can be calculated.

Here's an example. On 1994 May 04 [Wed] two successive blocks showed the following, where Rev/256 is the "raw spin count" or the item SC-ROH in the Navigation display of P3C.EXE

Block	Time	Rev	Rev/256
1	09:41:07	0	72
2	09:41:34	9	97

That's $9 + (97-72)/256 = 9.098$ revolutions in 27 seconds, or 20.22 rpm.

Accuracy

Now a moment's thought will tell you that if time is only given to 1 second precision then this calculated spin-rate can only be accurate to 1 part in 27, or 4%. To get greater accuracy you therefore need to take data over a longer period. The surprising thing is that this period can actually be many hours! If data is collected over two hours for example, your spin-rate measurement accuracy can be of the order of 0.00001 rpm, or well under 1 part per million.

Processing more than trivial amounts of data by hand quickly gets very tedious and error prone. But if you plot a graph of angle vs time then the slope is spin-rate. Your hand calculator probably has a function that lets you enter <y,t> pairs and will do this slope fit for you, and in some cases give an estimate of error.

If you are more ambitious you could use your computer to do the same thing. Indeed it could extract the data from a log file (xxxxxxx.DAT) and thus save you any typing at all. The time (H,M,S,S/100) is located at bytes 491-488 of the 512 byte block, and the raw spin count at byte 458. [3]

You'll notice that time is available to more precision than P3C.EXE displays, 20ms resolution in fact. This means that two successive raw spin count values give a spin rate calculation to approx 0.01 r.p.m accuracy. You'll also notice that the whole number of revolutions (column 3 in the first table) is unfortunately not telemetered. So you have to provide it by inference. You know beforehand what the spin rate is more or less because you can count the spin modulation beats. There's about 9 revolutions in 27 seconds at 20 r.p.m, so the rough guess only needs to be within 10%.

More Accuracy

Here's a table of data containing five points taken over a 2.5 minute period:

Block	HH MM SS.ss	Rev	Rev/256
1	09 41 07.16	0	72
2	09 41 34.20	9	97
3	09 42 10.46	21	149
4	09 42 37.48	30	173
5	09 43 31.48	48	216

With this you'll get a spin rate of 20.1900 r.p.m., and an accuracy estimate of about 0.0007 r.p.m., astonishing precision given the simplicity of the experiment. As a matter of fact spin-rate is the most accurate OSCAR-13 quantity we can measure. I have even done this during a magnetorque, when spin rate is deliberately and subtly changed, and been able to see the minute fluctuations and compare them with simulation, and so significantly refine the simulator!

Spin rate falls a little every orbit, about -0.04 r.p.m/perigee at Hp=800 km, presumably due to drag. Since perigee height is now decreasing all the while until burn up at the end of 1996, spin rate variation will be most interesting to follow over the next 2-3 years.

Moral

Now where has all this got us? Oh yes, the moral. Looking back through my files I see that it is exactly 10 years ago, back in early 1984 I designed my AO-10 400 bps PSK data decoder.

Why? Simply because I could hear the weird burbling noise, and was fascinated to know what it all might mean. There wasn't anything available to do it (not true in fact, but I knew no better at that time). Of course I had to write a very simple test program to present the 512 bytes on my computer screen. To be honest I really knew next to nothing about OSCAR-10, still less its telemetry details.

Well with all these numbers, and the Amsat-UK OSCAR-10 Handbook [3] by my side, one thing that really fascinated me, because I understood it least, was a little number in byte #4A simply called "Instantaneous spin count". Meaningless. But it did change every block, so was interesting. In those days there was no-one you could ask questions of and get answers back (so what's new?). I was on my own.

After a lot of tinkering I managed to work out that it must be the fractional part of the spacecraft revolution angle, and devised some experiments to see what I could do with the data. One thing led to another, and I gradually divined what a lot of related telemetry numbers did, and then extrapolated that to how the Sun and Earth sensors might work and so on.

Cheek

For fun I started writing my experiences down, and passed them on to the editor of OSCAR News as I thought they might be of interest to someone else. Well he printed them OK, [4], and I did get a startling number of letters (hundreds) all of which were, and still are, replied to.

After about a year of this I began comment on the management of AO-10 because I had realised that there were aspects of OSCAR-10 that I seemed to know more about than the controllers, whom I had not met. What a cheek!

Umbrellas in the Mist

Well one of them (Ian Ashley ZL1AOX) kindly approached me for some further material, and one thing led to another and I got more and more involved with input to AO-10 management, then to planning AO-13 post launch operations.

Finally I was summoned in 1988 to the shrine at Marburg, Germany and anointed with my command ticket - official. I was

also given a wondrous large blue and white AMSAT-DL anti-mist umbrella which has been essential equipment ever since. It's quite useful in the rain, too.

Devoured

Thus have 10 years of my life been more or less pleasurably devoured. The point is, and I still insist on this without apology or affectation, anybody could have done it. All you need is enthusiasm and commitment. That's how all the satellite teams' personnel, and indeed AMSAT as a whole - designers, builders, controllers, authors, editors, fundraisers, organisers, commentators, net managers, gofers, members and all - came into being. They showed an interest, said "I can do that", and did.

Anyone can; that includes you. Just do it.

References

[1] P3 400 bps PSK Data Demodulator. Bare PCB and populated PCB from author. +44 954-210388. Kits and case from Ron Long W8GUS, Kiron Corporation, 1516

Essex Road, Columbus, OH 43221 USA, +1 (614) 481-0542. Populated PCB and kit from Bob Myers W1XT, Myers Communications, PO Box 17108, Fountain Hills, AZ 85269-7108, USA, +1 (602) 837-6492. See also Oscar News 1992 Dec No.98 p39 for prices, and ref [5].

[2] P3C.EXE software from most AMSAT groups, plus Long and Myers as ref [1]. Software for other computers includes TLM13II (BBC) and !TLM13 (Acorn) from Amsat-UK.

[3] OSCAR 10 Handbook, AMSAT -UK 1983. Present embodiment: OSCAR 13 Operations and Technical Handbook, AMSAT-UK, 1988. \$US6 or 3 pounds.

[4] Miller J.R.; Sensorship - A Question of Attitudes Part 1. OSCAR News No. 54 1985 Aug, p.2-8. Part 2 No. 55 1985 Oct, p.2-5.

[5] Krome E.; The New G3RUH 400 Baud PSK Demodulator, The AMSAT Journal (US), Vol. 17 No. 2 Mar/Apr 1994, p.8-10 & 17.

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AMSAT-NA Comments to NTIA on 2400 MHz Allocation

Before the
U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Washington, D.C. 20230

BACKGROUND

AMSAT is a not-for-profit District of Columbia corporation established in 1969. Together with our affiliated organizations in other countries, we have constructed, launched and operated approximately 27 satellites to date in the amateur-satellite service, of which the majority are presently still in operation. These currently operational spacecraft include high-altitude, Molniya-type orbit transponder satellites capable of sustaining two-way communication over terrestrial paths well in excess of 10,000 miles (AMSAT-OSCAR 10 and AMSAT-OSCAR 13), numerous low-earth-orbit (LEO) digital store-and-forward packet radio satellites, scientific and educational payload satellites, LEO analog transponder satellites, and several spacecraft featuring combinations of

In the Matter of)

)

Title VI of the Omnibus Budget)

NTIA

Reconciliation Act of 1993,)

Special Publication 94-27

Preliminary Spectrum Reallocation)

Report)

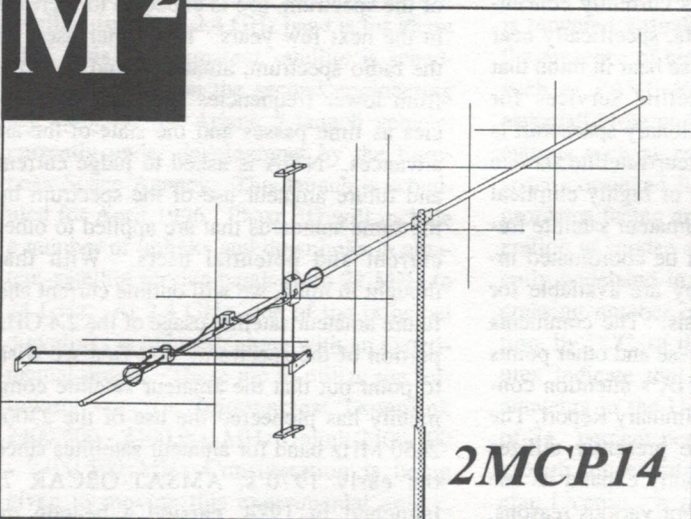
To: The Assistant Secretary for Communications and Information

COMMENTS OF THE RADIO AMATEUR SATELLITE CORPORATION

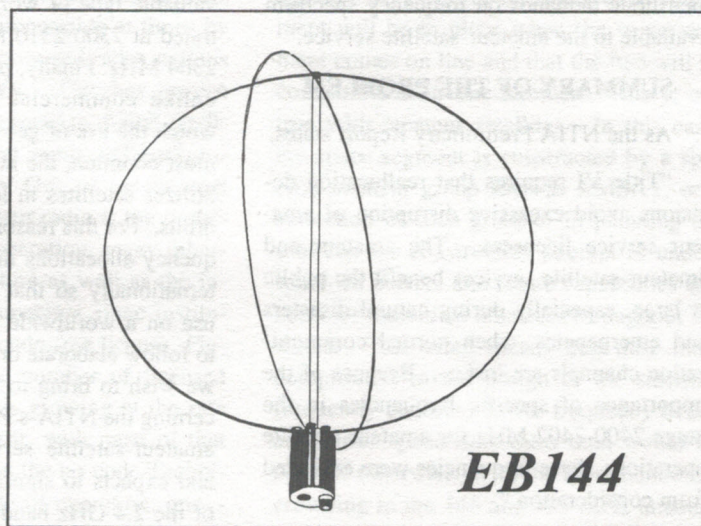
The Radio Amateur Satellite Corporation (AMSAT) respectfully submits these comments on the NTIA's Special Publication 94-27, Preliminary Spectrum Reallocation Report, February 1994, prepared under Title VI of the Omnibus Budget Reconciliation Act of 1993.

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these types of payloads. Additional satellites for the amateur-satellite service are planned or are presently under construction by AMSAT and its affiliate organizations in the United States and Argentina, Australia, Chile, Finland, Germany, Israel, Italy, Japan, Korea, Mexico, Russia and the United Kingdom. These groups are frequently associated with universities or have access to government or industry facilities in their countries. Indeed, owing to the worldwide and cooperative nature of amateur radio, the construction of satellites for the amateur-satellite service has emerged as a principal means of technology transfer to developing countries. One not-for-profit organization, Surrey Satellite Technologies Ltd., associated with the University of Surrey in the United Kingdom, has built or aided in the construction of eight such satellites, with more on the way. AMSAT itself is currently working with amateur satellite construction groups in nearly a dozen countries to build the fourth and most advanced in a series of elliptical orbit amateur satellites we call "Phase 3D". The next ten to twenty years is certain to see a further proliferation of this highly beneficial activity, with commensurate demands on frequency spectrum available to the amateur-satellite service.

SUMMARY OF THE PROBLEM

As the NTIA Preliminary Report states,

"Title VI requires that reallocation decisions avoid excessive disruption of amateur service licensees. The amateur and amateur-satellite services benefit the public at large, especially during natural disasters and emergencies, when normal communication channels are lost. . . . Because of the importance of specific frequencies in the range 2400-2402 MHz for amateur satellite operations, these frequencies were excluded from consideration."

AMSAT commends NTIA for excluding 2400-2402 MHz from the proposed reallocation, as these frequencies are of vital importance to spacecraft operations in the amateur-satellite service, for satellites in current use as well as those under construction. However, in the readily foreseeable future, AMSAT anticipates greatly increased demand for amateur satellite operations in that portion of the spectrum, far more than can reasonably be accommodated within a 2 MHz band. It is certainly too restricted to accommodate such wideband techniques

as fast-scan television, even if compression techniques are employed. AMSAT hopes to be able to employ such modes on future spacecraft. The 10 MHz wide 1260-1270 MHz uplink-only amateur-satellite service allocation is available for such applications, and a similar bandwidth is needed as a downlink at 2400 MHz. In view of these anticipated future needs of this service, especially for space-to-earth downlinks with relatively weak signal strengths on the earth's surface, we urge that this sub-band be expanded to 2400-2410 MHz. In addition, the Preliminary Report proposes a band at 2417-2450 MHz to be shared by the amateur and amateur-satellite services. While it may be possible to accommodate some earth-to-space uplinks in this range, we are very concerned that, in the metropolitan and suburban areas where most licensed amateurs live, interference levels from microwave ovens and ISM devices would be severe enough to render the frequencies in question very difficult to use for satellite applications. It would also be unsuitable for experimental weak-signal amateur operation such as earth-moon-earth and long-haul tropospheric work. This potentially valuable type of work is currently concentrated at 2300-2310 MHz, specifically near 2304 MHz. Finally, please bear in mind that unlike commercial satellite services for which the use of geostationary spacecraft is most common, the amateur-satellite service utilizes satellites in low or highly elliptical orbits. For this reason, amateur satellite frequency allocations must be coordinated internationally so that they are available for use on a worldwide basis. The comments to follow elaborate on these and other points we wish to bring to NTIA's attention concerning the NTIA's Preliminary Report. The amateur-satellite service presently utilizes and expects to significantly expand its use of the 2.4 GHz band. For various reasons, this band is a prime area of the spectrum for amateur communication experiments and applications. Due primarily to the extremely high cost of geostationary satellites, the amateur-satellite service presently does not utilize such spacecraft. Therefore, satellites in the amateur-satellite service are in lower or elliptical orbits that cover virtually the entire earth, albeit not all regions simultaneously. Consequently, the frequencies used by amateur satellites must be available worldwide. Thus, unlike terrestrial applications or those involving geostationary sat-

ellites, allocations of spectrum to the amateur-satellite service must be made consistently throughout the world, rather than on a national or regional basis. Therefore, any decisions with regard to allocations for the amateur-satellite service made in the United States must be coordinated with other governments. Otherwise, the results are likely to prove useless for the purposes for which they are intended. A case in point is the 3400-3410 MHz amateur-satellite service allocation currently provided for in the ITU Table of Allocations. This segment is stated as being available, but in Regions 2 and 3 only. Since it is not available in Region 1, it has not yet been employed for amateur-satellite use. In fact, this is the only band between 21 MHz and 24 GHz not being considered for inclusion in the Phase 3D spacecraft now under construction. With this background, AMSAT offers the following comments on the NTIA's Preliminary Spectrum Reallocation Report.

Level of Usage of the 2.4 GHz Band

Although current amateur and amateur satellite use of the 2.4 GHz band may be light by standards used to judge other parts of the spectrum, use is expected to increase in the next few years. Like other users of the radio spectrum, amateurs tend to move from lower frequencies to higher frequencies as time passes and the state-of-the-art advances. NTIA is asked to judge current and future amateur use of the spectrum by the same standards that are applied to other current and potential users. With that thought in mind, we will outline current and future amateur satellite usage of the 2.4 GHz portion of the spectrum. But first we wish to point out that the amateur satellite community has pioneered the use of the 2300-2450 MHz band for amateur satellites since the early 1970's. AMSAT-OSCAR 7, launched in 1974, carried a beacon on 2304.1 MHz. In addition, UOSAT-OSCAR 9 built at the University of Surrey in the U.K. and launched in 1981, contained beacons on 2401 and 10,470 MHz.

Current Usage

Several amateur satellites currently utilize the 2.4 GHz band: 1. AMSAT-OSCAR 13, launched in 1988, has a downlink on 2400.711-2400.747 MHz with a beacon at 2400.650 MHz. Use of this downlink has seen increasing use, especially over the past year, since the failure of the satellite's

435 MHz transmitter which was paired with an uplink on 1270 MHz. 2. UOSAT-OSCAR 11, built at the University of Surrey in the U.K. and launched in 1984, carries a beacon on 2401.5 MHz which continues to function. 3. PACSAT (AO-16), one of the four MICROSATs built in the U.S. in the late 1980's and launched in January 1990, contains a beacon on 2401.1 MHz which still functions. 4. DOVE (DO-17), another of the MICROSATs, has a beacon on 2401.220 MHz. This has proved invaluable in attempts to rescue this satellite from mission-threatening situations involving interference to the 144 MHz command receiver from the satellite's 145.825 MHz downlink transmitter. Often, the 2.4 GHz downlink has been the only means to confirm the satellite's acceptance of commands. 5. The French built Arsene amateur satellite includes a 16 kHz wide downlink at 2446.500 MHz. Unfortunately, that transmitter failed several months after launch. Before that failure, a number of amateurs around the world reported hearing this downlink.

Near-Term Plans

The most immediate planned amateur satellite use of the 2.4 GHz band is for Phase 3D. This large amateur satellite is scheduled for launch on the second engineering test flight of the Ariane 5 launch vehicle, currently under development by the European Space Agency. This launch is scheduled for April 1996. Phase 3D will include a number of uplinks and downlinks in amateur-satellite service bands from 21 MHz to 24 GHz. At 2.4 GHz, one of the principal downlinks is planned, along with an experimental uplink. These are to utilize the following specific frequencies: Downlink 2400.500 - 2400.900 MHz Uplink 2400.100 - 2400.500 MHz Consideration is being given to moving this experimental uplink, perhaps to the vicinity of 2410 or 2450 MHz. The latter would enable evaluation of the potential interference, in orbit, of various ISM devices including microwave ovens.

Long-Term Plans

The amateur-satellite service can be expected to make significant use of the 2.4 GHz band, especially for downlinks, over the next ten to twenty years. The intense crowding taking place on the lower VHF and UHF amateur bands necessitates the use

of the higher bands by amateur satellites. Particularly bad is the situation in the 144-146 MHz band, which is the only portion of the VHF spectrum presently allocated to the amateur-satellite service on a primary basis by the ITU. The ready availability of inexpensive equipment intended for the amateur market has resulted in extensive use of this band by non-amateurs for personal and commercial communications in many countries, especially in Asia and the Pacific Rim - despite ITU regulations to the contrary. First-hand observations by radio amateur astronauts flying in the Space Shuttle and cosmonauts aboard MIR have confirmed that this is a significant and growing problem for amateur space communications. Even in the U.S., where non-amateur use is not the problem that it is elsewhere, the 144-146 MHz band is becoming increasingly congested by various types of amateur terrestrial usage. This intense use is making the band increasingly difficult to use, especially for the relatively weak signal satellite downlinks. A similar situation is developing in the 435-438 MHz band allocated on a secondary basis by the ITU to the amateur-satellite service. In many parts of the world, use of this band for satellite uplinks is rendered virtually impossible at times by the presence of high-powered radar stations such as PAVE PAWS. This has proven especially true with respect to digital applications such as packet radio and earth-to-space command links. One of the internal problems facing amateur radio is the proliferation of modes of operation, many inherently wideband in nature as well as the increasing number of amateurs since institution, by FCC, of the code-free license. Figures indicate that the number of licensed amateurs in the U.S. is growing at the rate of 7+ percent per year, with most of that growth concentrated in the no-code Technician License. A mode of operation, growing in popularity, is fast-scan amateur television. Several manufacturers currently offer low cost amateur television transmitters for the 420-450 MHz band. As no such commercial amateur television equipment is manufactured for any of the higher amateur bands, this band is receiving the brunt of amateur television operation. Since amateur FM repeaters occupy almost all of the 440 to 450 MHz range, and 420 to 430 MHz is not available everywhere in the U.S., most amateur television operation takes place between 430 and 440 MHz. Many of these

commercial amateur TV transmitters, and most home constructed units, transmit signals 8 MHz in width (both sidebands), often causing interference to reception of amateur satellites in the 435 to 438 amateur-satellite service band as well as to weak signal work taking place near 432 MHz. This problem is greatly exacerbated in the many other countries of the world where only 430-440 MHz, or parts thereof, is available for amateur operation. As a result of this worsening situation in the lower frequency bands, groups planning and implementing amateur satellites in the future will have to use the higher frequency allocations. The specific selection of bands must, however, take into consideration the economic status and technical expertise of potential users worldwide, not merely those in the United States or in other highly developed countries. Amateur satellites are completely different from satellites built for other applications. In the case of commercial or government satellites, while the spacecraft is being constructed and prepared for launch, suitable ground station equipment is being developed and deployed. Usually, both of these are funded and directed by the same company or government agency. This assures that the ground equipment will be in place when the space segment comes on line and that the two will be compatible with one another. This is not true with amateur satellites. In this case, the space segment is constructed by a specific amateur group such as AMSAT, or a collection of such groups. In planning the satellite, the constructors attempt to understand the current and future capabilities and needs of individual amateurs throughout the world. This often means that they must compromise in the design of the satellite, frequently choosing lower frequency bands and lower speed data rates than would be optimal otherwise. With the aforementioned crowding in the 145 and 435 MHz amateur bands, future amateur satellites will depend heavily on the next higher bands, 1.2 and 2.4 GHz. The amateur-satellite service allocation in the 1.2 GHz region, 1260-1270 MHz, is designated for use as uplinks only. Under ITU regulations, the lowest available frequency range for amateur satellite downlinks above 438 MHz is 2400-2450 MHz. As noted previously, the 3400-3410 MHz amateur-satellite service allocation is not available worldwide. The next highest downlink allocation is 5830-5850 MHz. Because of the congestion on the lower

bands and the economic and technical considerations on the higher bands, it is the 2400 MHz band which will bear the greatest burden of supporting the growth of the amateur-satellite service over the next ten to twenty years. It is difficult to see how it can do so if only 2 MHz of spectrum is available. Currently, the amateur-satellite service allocation in the 2.4 GHz region is 2400-2450 MHz, both in the FCC and international tables. It would appear that to efficiently use the 10 MHz wide 1.2 GHz uplink assignment, a like assignment at 2.4 GHz would be reasonable and necessary. While there is a commonality of interest between amateurs who use weak signal modes such as earth-moon-earth or long haul terrestrial means of propagation, and those amateurs participating in satellite operation, use of common or nearby frequencies by these two groups often leads to mutually destructive interference. Furthermore, relatively narrow allocations, available on a primary basis, is the best approach of accommodating and encouraging both of these potentially valuable activities. Currently, most amateur weak signal work done in the 2.4 GHz band is done in the vicinity of 2304 MHz, although in some countries other frequencies are employed due to non-availability of the 2300-2310 MHz segment to amateurs. Like satellite operation, although to a lesser extent, weak signal operation is best accomplished on common worldwide allocations. This is especially true of earth-moon-earth operation. Needless to say, successful earth-moon-earth operation requires the utmost in performance of all elements of the system from high power amplifiers, receive pre-amplifiers and antennas. Unfortunately, wide frequency separations between transit and receive frequencies, necessitated by varying allocations, often leads to less than optimum equipment performance, especially in the case of antennas.

Advanced Technology Planning and Experimentation

New satellite and ground-based telecommunications systems being authorized by the FCC have benefitted from the advances made in experiments developed for use in the amateur-satellite service. To cite one example, the LEO satellite systems now being authorized by the FCC use packet radio hardware and software technologies originally developed by the amateur radio community for use in the amateur-satellite service, particularly for the amateur

MICROSATs and the University of Surrey's UOSATs. As an extension of this spinoff concept, the amateur-satellite community is evolving standards for high-speed digital data and digital video transmission using compression technologies that are ideally suited for small satellite applications. In order to test and implement this type of technology, frequency allocations with adequate bandwidth are essential. The 2.4 GHz frequency band is the best suited frequency band for the downlink for this type of experimental digital communications. The communications transponders used would pair uplinks at 1260-1270 MHz with downlinks in the 2400-2410 MHz frequency band. Amateur satellite groups are also doing pioneering work in the development of high efficiency, high-power amplifiers for this portion of the radio spectrum. Linear 2.4 GHz amplifiers with efficiencies as high as 40 percent have already been developed by the amateur community. AMSAT's Phase 3D spacecraft will carry solid-state amplifiers for the 2.4 GHz amateur-satellite band capable of in excess of 100 watts of RF power output and over 10 kilowatts of effective radiated power. These technologies under development by amateur groups, when taken together and with an adequately wide 2.4 GHz amateur-satellite allocation, will provide powerful demonstrations of low-cost digital video and data transmission techniques. These technical approaches differ from direct broadcast technologies because they are bi-directional and will involve different multiple amateur uplink stations. Both time-division and code-division multiple access techniques are under consideration. In addition to experimentation with digital video and high-speed packet data links, several amateurs have expressed an interest in investigating low-cost spread spectrum techniques. Spread spectrum communications experiments are important because they may lead to feasible methods of spectrum sharing by various commercial satellite and terrestrial services, applications currently under consideration by the FCC.

Interference Considerations

We have already mentioned interference experienced in the amateur-satellite service as a result of high powered devices such as radars and interference arising from amateur and non-amateur use of the 144-146 and 435-438 MHz bands. Some interference from radars is also present in the 1260-1270 MHz uplink band. The 2.4 GHz band

presents a unique challenge in that ISM devices, principally microwave ovens, are present. Microwave ovens are particularly troublesome for amateurs because they are found in most homes, and most amateurs operate in residential areas. For this reason, amateur and amateur-satellite operation should be afforded a part of the band as far away from that occupied by ISM devices as possible. NTIA is reminded that, following a study done for the Voice of America, the U.S. sought an allocation at WARC-92 for broadcast-satellite service (sound) from 2310-2360 MHz - as far away, in that band, from the 2450 MHz ISM center frequency as possible. AMSAT wonders how close to 2450 MHz the majority of microwave ovens remain. We would welcome any data NTIA may have on the subject.

Recommendations

In the light of the above considerations, AMSAT recommends that no less than 10 MHz, from 2400-2410 MHz, be set aside on a primary basis for the amateur and amateur-satellite services. In addition, as much of the band from 2410-2450 MHz as possible should be allocated to the amateur and amateur-satellite services at least on a secondary basis. This will serve the needs of various amateur modes such as amateur television, as well as providing frequency space for possible amateur satellite uplinks which are not likely to be as sensitive to interference from wideband amateur terrestrial applications or from ISM devices as are amateur satellite downlinks. AMSAT also urges that a small slice of spectrum (1 to 2 MHz), somewhere in the 2.3-2.4 GHz region be allocated to the amateur service on a primary basis to accommodate terrestrial and earth-moon-earth weak signal operation. For the reasons discussed earlier, this segment should not lie within the 2400-2410 MHz segment to be used for satellite work. Owing to the extremely weak signal strengths involved, it should be located as low as possible in the band in order to avoid destructive interference from ISM devices operating around 2450 MHz.

RESPECTFULLY SUBMITTED,

Radio Amateur Satellite Corporation

P. O. Box 27

Washington, D.C. 20044

By William A. Tynan President

May 11, 1994

Current Amateur Satellite Frequencies

Satellite	Callsgn	Uplink	Downlink	Type
AO-10		435.03-435.18 LSB/CW	145.975-145.825 USB/CW	Mode B Analog
AO-13		435.423-435.573 LSB/CW	145.975-145.825 USB/CW	Mode B Analog
AO-13		435.602-435.606 USB/CW	2400.715-2400.749 USB/CW	Mode S Analog
FO-20		145.9-146.0 LSB/CW	435.9-435.8	Mode J Analog
AO-27		145.85 FM	436.80 FM	Part-Time Repeater
AO-21		435.016 FM	145.987 FM	Part-Time Repeater
RS-10		145.865-145.905 USB/CW	29.360 - 29.400	Mode A Analog
RS-12		21.21-21.25 USB/CW	29.41-29.4	Mode K Analog
AO-16	PACSAT	145.90, .92, .94, .96 FM	437.0513 SSB	1200 Baud PSK
DO-17			145.825 FM	1200 Baud AFSK/ voice
WO-18			437.104 SSB	1200 Baud PSK (img)
LO-19	LUSAT	145.84, .86, .88, .90 FM	437.1258 SSB	1200 Baud PSK
FO-20	8J1JBS	145.85, .87, .89, .91 FM	435.91 SSB	1200 Baud PSK
UO-22	UOSAT5	145.9, .975 FM	435.12 FM	9600 Baud FSK
KO-23	HL01	145.85, .90 FM	435.175 FM	9600 Baud FSK
KO-25	HL02	145.98 FM	436.5 FM	9600 Baud FSK
IO-26	ITMSAT	145.875, .90, .925, .95 FM	435.822 SSB	1200 Baud PSK
POSAT	POSAT1	145.975 FM	435.2777 FM	9600 Baud FSK

- 1) Frequencies shown are without Doppler compensation. For typical digital satellite pass the original signal will be about 8 kHz higher than what is shown.
- 2) WO-18 Webersat transmits experimental and image data and can be captured in KISS mode via PB or TLMDC.
- 3) Except for FO-20 the digital sats use a program suite containing PB/PG/PFHADD/PHS or WISP. The broadcast callsign (in PB.CFG) is the satellite's callsign with an SSID of -11. The connected mode callsign (in PG.CFG) is the satellite's callsign with an SSID of -12.
- 4) When in mode JD, FO-20 can be worked with any packet program. Connect to 8J1JBS. FO-20 currently alternates between modes JA and JD on a weekly basis. Check ANS bulletins for schedule.
- 5) AO-10 is no longer controllable but the transponder works when the satellite is in sunlight.
- 6) For AO-10 and AO-13, transmit LSB, receive USB. As transmitted frequency is increased the received frequency will decrease (inverting transponder).
- 7) AO-21 currently operates on a 10 minute schedule with FM repeater, WEFAX image transmission, and 1200 baud AFSK telemetry in each cycle.

Satellite Orbital Elements

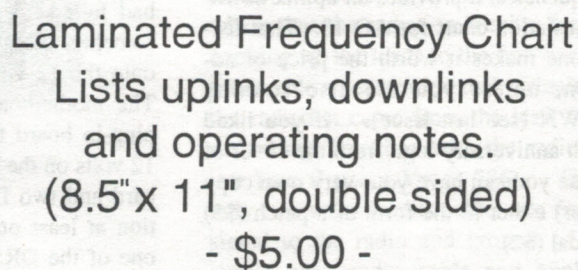
by Ray Hoad, WA5QGD

Satellite	AO-10	UO-11	RS-10/11	AO-13	FO-20	AO-21	RS-12/13
Catalog Number	14129	14781	18129	19216	20480	21087	21089
Epoch Time	94150.69677441	94159.58005905	94159.90407672	94157.28362721	94157.45457424	94157.40570894	94156.58678752
Element Set	287	699	908	923	695	477	698
Inclination	27.1154	97.7865	82.9230	57.7964	99.0344	82.9402	82.9214
RA of Node	325.0714	174.7086	334.9649	248.7429	311.3041	150.6882	20.0542
Eccentricity	0.6022081	0.0011152	0.0013215	0.7212622	0.0541277	0.0036807	0.0029669
Arg of Perigee	182.4311	302.8221	50.4111	343.0560	3.8142	111.8581	137.8770
Mean Anomaly	172.2849	57.1910	309.8211	1.9835	356.6842	248.6496	222.4693
Mean Motion	2.05880205	14.69217542	13.72338053	2.09726498	12.83226187	13.74540847	13.74041810
Decay Rate	-.00000061	.00000144	.00000044	-.00000630	.00000028	.00000094	.00000043
Epoch Rev	8242	54904	34877	4578	20275	16810	16705
Satellite	UO-14	AO-16	DO-17	WO-18	LO-19	UO-22	KO-23
Catalog Number	20437	20439	20440	20441	20442	21575	22077
Epoch Time	94157.23861139	94156.73481228	94156.76023471	94157.22514543	94157.20405622	94157.69084411	94158.44314725
Element Set	0	799	799	801	798	502	397
Inclination	98.5848	98.5957	98.5973	98.5958	98.5980	98.4354	66.0817
RA of Node	242.1624	242.8851	243.2299	243.6917	243.9234	232.4004	300.3826
Eccentricity	0.0010423	0.0010618	0.0010714	0.0011334	0.0011512	0.0007618	0.0014038
Arg of Perigee	220.2693	223.5361	222.5466	221.5982	222.2726	329.4237	289.0245
Mean Anomaly	139.7718	136.4969	137.4883	138.4365	137.7572	30.6509	70.9248
Mean Motion	14.29844994	14.29899297	14.30038782	14.30012443	14.30108993	14.36917795	12.86286506
Decay Rate	-.00000038	.00000030	.00000036	-.00000081	.00000024	.00000043	-.00000037
Epoch Rev	22802	22796	22798	22805	22806	15157	8553
Satellite	AO-27	IO-26	KO-25	POSAT	MIR	MET-2/17	MET-3/2
Catalog Number	22825	22826	22830	22829	16609	18820	19336
Epoch Time	94157.72326327	94157.21446021	94157.71795359	94157.72294064	94159.91476795	94158.84525915	94159.88197195
Element Set	296	296	301	289	636	305	294
Inclination	98.6523	98.6522	98.5510	98.6496	51.6469	82.5399	82.5397
RA of Node	233.6335	233.1665	231.0277	233.6944	227.7363	276.0117	329.5606
Eccentricity	0.0007784	0.0008350	0.0011336	0.0009240	0.0002167	0.0015611	0.0016070
Arg of Perigee	242.3709	244.4511	203.1377	227.5945	29.8936	203.5072	286.8557
Mean Anomaly	117.6684	115.5800	156.9297	132.4448	330.2213	156.5376	73.0807
Mean Motion	14.27625201	14.27729220	14.28055571	14.28028083	15.56279933	13.84716189	13.16967913
Decay Rate	.00000005	.00000023	.00000011	.00000046	.00000586	.00000041	.00000051
Epoch Rev	3619	3612	3620	3620	47475	32106	28216
Satellite	MET-2/18	MET-3/3	MET-2/19	MET-2/20	MET-3/4	MET-3/5	MET-2/21
Catalog Number	19851	20305	20670	20826	21232	21655	22782
Epoch Time	94156.51345801	94159.25725234	94157.67818155	94157.46205984	94156.99788935	94156.88810524	94157.22615171
Element Set	294	68	799	807	705	714	307
Inclination	82.5167	82.5552	82.5475	82.5253	82.5415	82.5508	82.5494
RA of Node	153.2269	276.1489	216.8127	154.5153	177.5026	124.7250	215.1192
Eccentricity	0.0012537	0.0005929	0.0015578	0.0015154	0.0011846	0.0011681	0.0020724
Arg of Perigee	260.2043	323.3208	170.2858	76.7190	211.6813	224.6140	257.2687
Mean Anomaly	99.7701	36.7508	189.8605	283.5664	148.3605	135.4044	102.6153
Mean Motion	13.84365397	13.04422019	13.84188682	13.83582339	13.16462992	13.16830633	13.83008098
Decay Rate	.00000022	.00000044	.00000038	.00000049	.00000050	.00000051	.00000040
Epoch Rev	26607	22173	19916	18627	14988	13497	3857

THINKS



25th Anniversary Decal - \$2.00
25th Anniversary Patch - \$5.00



Enclosed is my valuation of [REDACTED]

Name.....

Address.....

City..... State..... ZIP.....

May/June 19

Heard on the Downlink

by John Hansen, WAØPTV
49 Maple Avenue
Fredonia, NY 14063

New Goodies Available from AMSAT HQ

There are a number of new goodies available from AMSAT HQ that were made available at Dayton for the first time. Advertising for these items hasn't been formally constructed yet so you still have time to be the first on your block to own them. For those of you who run Windows and are active on the digital satellites, there is a new Windows-based satellite groundstation program available called WISP. I've not run it myself yet, but am told by those who have that it is the cat's meow. The AMSAT Journal will run a complete review and description of this product in the next issue. If you want to get a jump on that issue you can obtain your own copy for \$30.

WinSat is a new Windows-based satellite tracking program. It is available for \$30 to members (\$50 non-members). A new satellite laminated frequency chart is also available for \$5. I saw this at Dayton and can tell you that it is more than worth the cost. In addition to providing data on satellite frequencies, it provides an uplink/downlink translation chart for AO-13. That feature alone makes it worth the price of admission, unless you are also running UPDOWN (see last issue). If you liked the 25th anniversary logo from the cover of last issue you can have your very own copy (in color) either in the form of a patch (\$5) or a decal (\$2).

Finally Gould Smith has completed the job of revising the PACSAT Beginner's Guide (which has been renamed *The AMSAT-NA Digital Satellite Guide*) for those of you who are just getting started on the digital satellites. This is one area where it is extremely difficult to stay current because the field is changing so quickly. Gould has done an outstanding job of bringing this guide up to date with an easy to read, comprehensive description of how to get going. For your \$12 you also get a copy of the PB/PG groundstation software.

Credit Where Credit is Due

You will note that starting with this issue the cover of the AMSAT Journal has been substantially redesigned. This is the work of Dwight Clayville, N7CHC, who responded to a request for designers I made a

couple of issues ago. Amazing how much talent is in AMSAT, eh? Thanks Dwight.

There She Blows!

In the January/February issue of this Journal I offered my BBS as a point of entry to those of you who were interested in trying out the digital satellites without incurring the expense of purchasing your own equipment. A significant number of folks took me up on this offer. However, in the middle of May the computer that ran that BBS blew up. I'm still not exactly sure how it happened. I was putting my newly-built Trackbox in a metal case (see below) and I'd unplugged the cable that goes from the rotator box to the Trackbox. This cable had fallen across the heat sink fins of my power supply and caused something to short to ground. As a result there was smoke coming from the end of the cable.

Now here's the odd part. The only thing that that cable was connected to was the control box from my Yaesu 5400 rotator. I was afraid that something might have blown in the control box as a result of the "fire" but in fact it came through unscathed. At the time that I was distracted by the smoke, however, I noticed that my BBS computer had failed. Upon inspection I found that somehow a rather large voltage had gotten onto the 12 volt line on the computer bus. The motherboard was fried, as was every plug-in board that had a line connected to 12 volts on the bus. This included the video card and two DRSI PCPA cards. In addition at least one radio that was hooked to one of the DRSI cards lost its microphone audio amp stage as well. I suspect that two TAPR 9600 baud modems that I had hooked to one of the DRSI cards are gone as well, but that has not as yet been fully investigated (they draw 12 volts off the computer bus).

The voltage was so severe it literally blew apart one of the chips on one of the DRSI cards and burned part of the positive bus trace right off the board. The good news is that the really expensive stuff, like the brand new 15 inch monitor, the computer's RAM and the hard drive are still in good shape. I mention this here not to seek sympathy, but rather to explain why the offer of dial up satellites is no longer good. There are, however, a number of other gateway nodes operating in the United States and elsewhere. As yet, I don't know any of these that have a telephone port, but

I know of at least one that is contemplating adding it. I keep you posted when I find out anything about its availability.

Cheap 9600 Baud

Operating at 9600 baud is getting cheaper and cheaper. AEA, PacComm and Kantronics were all showing new 9600 baud products at Dayton with street prices under \$200. The PacComm product was particularly interesting because, while it did not include 1200 baud operation, it did permit operation at data rates up into the 56 Kbaud range (assuming the proper RF equipment).

The manufacturers of these products seem to be particularly targeting them at the terrestrial market, perhaps because it is perceived as being a larger potential market than the satellite market. One manufacturer introduced a 9600 baud TNC/modem combination last year that simply did not play well when interfaced to satellite radios in the usual way, presumably because of an impedance matching problem. As a result, I recommend that you talk to someone who is operating digital satellites with the TNC/modem you are considering using before you buy it.

PacComm told me that the new product had not been tested on digital satellites yet, but suggested they might send me one to test in that application when they had more of them available. I'll keep you posted.

In the meantime, if you are looking for cheap 9600 baud capability for multiport terrestrial applications there is an opportunity now available that is nearly unbeatable. I noticed that at least one major amateur equipment dealer is remaindering the DRSI PCPA type 3 board for under \$80. For a couple of years I have been using one of these boards with two TAPR 9600 baud modems to obtain two 9600 baud ports on my bbs (well, up until recently, that is). Given that the modems are under \$80 each (for TAPR members), this provides two 9600 baud ports and an average cost of about \$120 each. Tough to beat.

By the way, have you noticed the great lengths to which the manufacturers are going to protect their high end satellite radio markets from competition from their own products? Many of the new lower priced FM radios that are currently being introduced could easily be used for satellite operations except that this capability is specifically being designed out. Some have

lower frequency limit of 440 Mhz, others have 12.5 kHz IF filters. I prowled around Dayton looking for a manufacturer that had any interest at all in putting these radios on 9600 baud digital satellites and virtually all of them said it would be impossible. Given how tight the IF filters are on some, it will be interesting to see how well they work in terrestrial service at this speed as well. I would be interested in hearing about your experience with 9600 baud plug and play radios and in particular the AMSAT Journal would be most interested in hearing from

anyone who has modified any of these radios for satellite use. Inquiring minds want to know!

Hidden Transmitters

Sure, everyone knows that computers can't run without oscillators and as a result all computers are essentially low power transmitters. I knew that, but for those of us who are mechanically inept, metal-working is an activity that requires roughly the same degree of skill as brain surgery. However, I had got my TAPR/JAMSAT

Trackbox kit up and running and needed to put it in some sort of container, at least temporarily, until I could get it properly fitted in a metal enclosure. I've always felt that cardboard-working was an order of magnitude easier than metal-working, so I cut the proper holes in a cardboard box and the Trackbox was off and running. Sure, it made too much noise for me to successfully operate Mode B on AO-13, and I was never going to get FCC class B certification this way, but it produced little or no interference on 70 cm and I really only needed it for microsat operation anyway, so I figured I was off and running.

That's before I found the spur on 154.815 MHz. It seems that this frequency is normally inhabited by the local police, and while they weren't much concerned that I was putting out a signal on this band (they probably all run CTCSS anyway) my next door neighbor with a scanner was certainly not impressed. I was in the process of putting it in a better shielded box the day my computer blew up. I mention this not to warn you against putting your Trackbox in a cardboard box: surely nobody besides me is foolish enough to try that! However, surrounding it with metal had very little impact on the RF output of the device.

The next step was to add snap-on chokes to all the leads. No difference. Ok, so where was the radiation coming from? By hooking up the leads to the box one by one I was able to determine that virtually all of the radiation came from the lead that connected the Trackbox with the radio's CAT interface (I use a Yaesu 736). There are only two wires in this cable, one for a TTL signal to the radio and ground. I used a single wire audio cable and hooked the cable's shield to the ground connection. A continuity tester revealed that the ground connection on the Trackbox radio interface was, in fact tied to the box itself. So I replaced the cable between the Trackbox and the radio with a two conductor shielded cable and hooked the two wires to the appropriate pins on the connector and connected the shield directly to the cable body at both ends. There is still some radiation in the shack, but it is way down and the neighbor is now happy.

Was it an improperly connected ground or just a faulty cable in the first place? Actually I don't know, but if you are having trouble with Trackbox radiation (and I know many of you are) try looking into the radio connection for a fix.

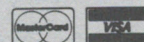


Receive Only	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	\$29.95
P50VD	50-54	<1.3	15	0	DGFET	\$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	\$79.95
P144VD	144-148	<1.5	15	0	DGFET	\$29.95
P144VDA	144-148	<1.0	15	0	DGFET	\$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	\$79.95
P220VD	220-225	<1.8	15	0	DGFET	\$29.95
P220VDA	220-225	<1.2	15	0	DGFET	\$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	\$79.95
P432VD	420-450	<1.8	15	-20	Bipolar	\$32.95
P432VDA	420-450	<1.1	17	-20	Bipolar	\$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	\$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	\$59.95
SP50VD	50-54	<1.4	15	0	DGFET	\$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	\$109.95
SP144VD	144-148	<1.6	15	0	DGFET	\$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	\$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	\$109.95
SP220VD	220-225	<1.9	15	0	DGFET	\$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	\$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	\$109.95
SP432VD	420-450	<1.9	15	-20	Bipolar	\$62.95
SP432VDA	420-450	<1.2	17	-20	Bipolar	\$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	\$109.95

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Dear Satellite Doctor:

I have taken the plunge and have become active on RS-10. I'm using a Yaesu FT-290R, RF Concepts 30 watt amplifier, and an M2 Eggbeater for the uplink. My downlink equipment is an ICOM 725 and a Mosley TA-33 Yagi. Both antennas are 35 feet above the ground, and my home is 140 feet above mean sea level. I have been very active on CW, and have recently started using SSB. My home is in Southern New Jersey.

After loading a new set of Keplerian Elements into my tracking program, I see there are some orbits with a mutual window between the US and the UK. I've been regularly working RS-10, but have yet to hear any stations from Great Britain. Are there frequency restrictions on hams in the UK? Do I need to upgrade my downlink equipment to get higher signal strength on receive?

Thanks,

Active Satellite Operator and AMSAT Member

Groundstation Diagnosis

by Walter Daniel, KE3HP

Hams in the United Kingdom are active on 2 meters and certainly use RS-10. I believe that the recent intersatellite link tests (ground to AO-21 to RS-10 to ground) were organized by British amateurs. Tracking programs show times of mutual visibility between the British Isles and the North-

eastern U.S./Eastern Canada, yet transatlantic QSOs through RS-10 seem rare. What is the problem?

Tracking programs typically consider a satellite in view if the elevation is above 0 degrees. In reality, most stations have ra-

dio horizons well above 0 degrees. For example, my house lies at the foot of a bluff where the horizon is about 20 degrees elevation on all sides. I simply cannot work a satellite unless its elevation is more than 20 degrees.

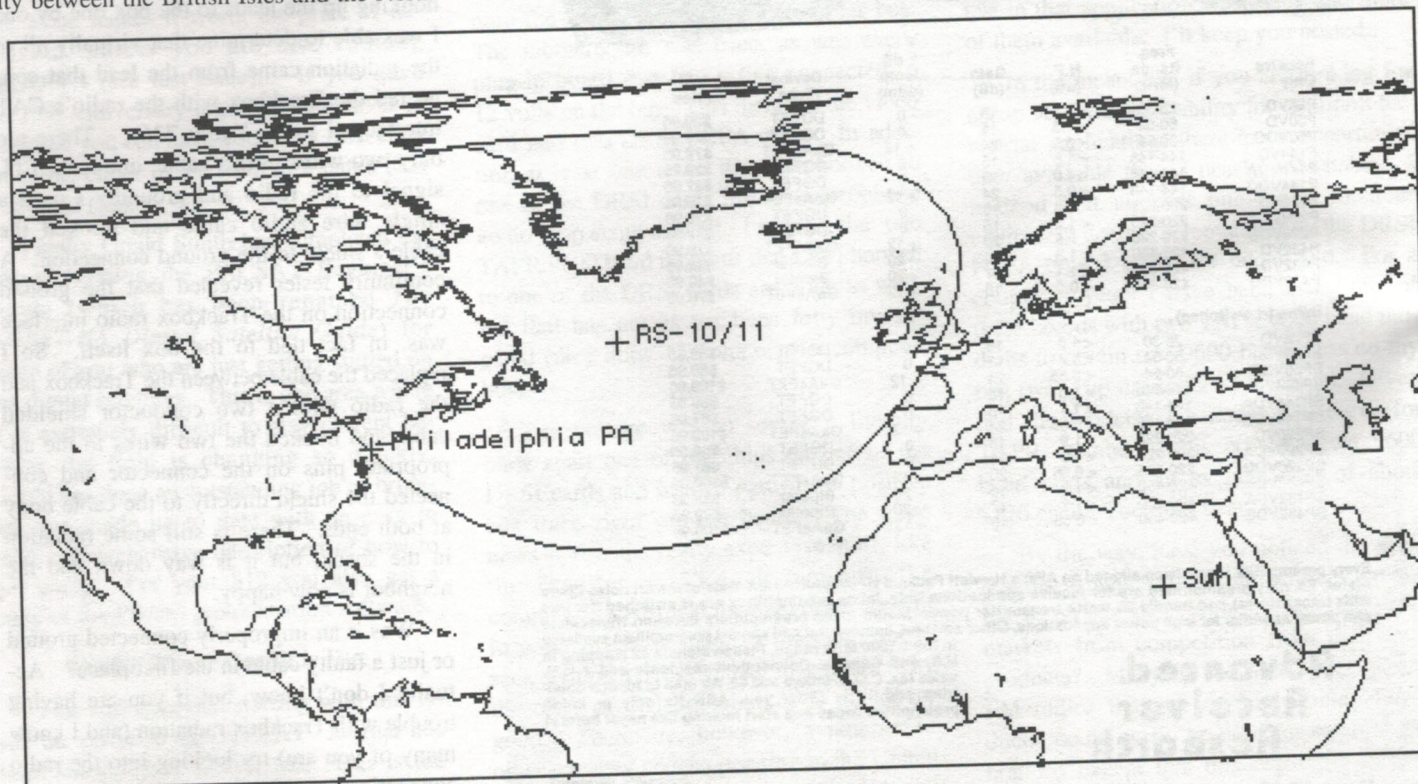


Figure 1. RS-10 View Circle with 5 Degree Horizon

I use a shareware Macintosh program called OrbiTrack. One of the unique features about the program is that the user can set the radio horizon for either a particular station or to a satellite. Figure 1 contains a view circle plot for RS-10 in which the circle indicates locations on the ground where the satellite is 5 degrees above the horizon. Note that the high latitudes make the circle appear to be stretched into an ellipse on this map projection. At the time the plot was made, the circle passed through Philadelphia while cutting through England. According to this plot, a ham in Birmingham, England could contact a ham in Philadelphia if both stations had horizons down to 5 degrees and both operators moved quickly. In practice, this QSO would be rather difficult.

Are transatlantic QSOs through RS-10 impossible? Not at all! I received a QSL and letter from a ham near Toronto that I had worked via RS-10. VE3YCO reports that he tried calling CQ RS-10 when the

satellite was over the middle of the Atlantic Ocean. It took a few passes, but he eventually worked a G6 station. As he wrote, "To think I talked to the U.K. on 2 meters and 25 watts..."

When RS-15 is launched, you'll be able to work stations in Western Europe using Mode A with regularity. While the RS-15 hardware will be similar to that of RS-10, the orbit will be somewhat higher and the coverage circle will be larger. The higher orbit (thus weaker signals) may make the use of a 10 meter preamp necessary. You can add the preamp for use with RS-10 now—new units cost as little as \$60 or you can homebrew one.

You can make transatlantic QSOs with FO-20 today. I turned my Mode A station into a Mode JA station by adding a small 70 cm beam antenna, a 70 cm mast-mounted preamp, and a 70 cm-to-10 m downconverter (total cost of about \$200). I've heard UK stations through the satellite transponder here in Maryland, not far from

Southern New Jersey.

My diagnosis is that your station is fine. It is possible to work Britain from your QTH, but it will take perseverance and perhaps a bit of luck. Don't forget that Iceland, Bermuda, and the Caribbean are also within your reach!



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The Microwave Links Of P3D

by Karl Meinzer, DJ4ZC,
Chairman, AMSAT-DL

Translated by Ralph Lampenscherf,
DG1EFR

ed. note: This article first appeared in the January, 1994 issue of the AMSAT-DL Journal

During the last 2 years the satellite AMSAT P3D has taken clear shape. The so far largest amateur satellite (approx. 2.5 m diameter, 400 kgs) is in process of construction under syndicate management of AMSAT-DL and shall be launched with the second Ariane 5 in 1996. With AMSAT P3D there will be more importance attached to the microwave radio links; this article shall focus on the background behind this.

Choosing the frequency ranges for satellites will always mean having to make difficult decisions. On the one hand there are clear technical criteria which determine, according to the state of art and the size of the satellite, which are the optimum frequencies. In practice this way is only conditionally clear, because AMSAT has to keep an eye on the user community. The best frequencies are useless if the users cannot purchase

the required equipment and as a result the satellite is not used. Simply stated, the satellite must be accepted by the user community.

There are two major differences between the P3D satellite and the former P3 satellites as far as the radio links are concerned. First, the satellite's size and its 3-axis attitude control will allow the installation of maximum gain antennas consistent with the entire earth being within the antenna's beamwidth. Secondly, the usual hard-wired transponder system will be abandoned in favor of a matrix, which in principle will permit virtually any combination of receiver and transmitter (see Figure 1.)

Because of the matrix, the operating modes will be named with two letters instead of just one. The first letter will name the receiver on board the satellite whereas the second letter will name the transmitter. So mode SX will mean for example, that this "transponder" receives on 2400 MHz and transmits on 10,500 MHz.

It is interesting to examine the characteristics that these links will have on various frequencies. Considering that P3D will

fly in an orbit with an apogee height of 50,000 kilometers, from the satellite the earth will have a diameter of just approx. 13 degrees - which corresponds to a maximum gain of approx. 20 dBi (at higher gain levels the radiation pattern of the antenna will not cover the entire visible portion of the earth). On a 2.5 m large satellite this gain cannot be achieved on 70 cm or lower, but from 1260 MHz onwards the antennas are small enough.

So we are confronted with two different situations :

(1) On the microwave frequencies (1260 MHz and higher) the antenna gain of the satellite is 20 dBi, but on 70 cm and below the gain depends on the frequency, but will be considerably lower than 20 dBi. Assuming the same antenna sizes on the ground, this would mean that the effective link attenuation on the microwaves is constant, as the increase in antenna gain on the ground just compensates for the isotropic link attenuation. Actually the difficulty of producing power on the higher microwave frequencies (for example 10.5 GHz) and the increased pointing precision required for higher gain antennas leads to a preference of the using the lower microwave frequencies. (The receiver sensitivity is hardly a function of the frequency).

(2) On the VHF and UHF-frequencies the links tend to be unfavourable, because of the necessary decrease in antenna gain on the satellite. In addition, the effective noise temperature increases on the lower frequencies, however this effect will be partially offset by the fact that higher transmitting power can be produced more easily.

As a result, the lower microwave frequencies are the optimal ones. (If one would give up the demand to "light up" the whole earth, the optimum frequency would be higher. If, for example, only one tenth of the earth diameter shall be lighted up, the optimum frequency would increase by tenfold - which shows, that 12 GHz is nearly the optimum for the TV satellites.)

As mentioned before, the selection of the frequency has also to be oriented at the presence of the required acceptance by the users. In earlier satellites several modes

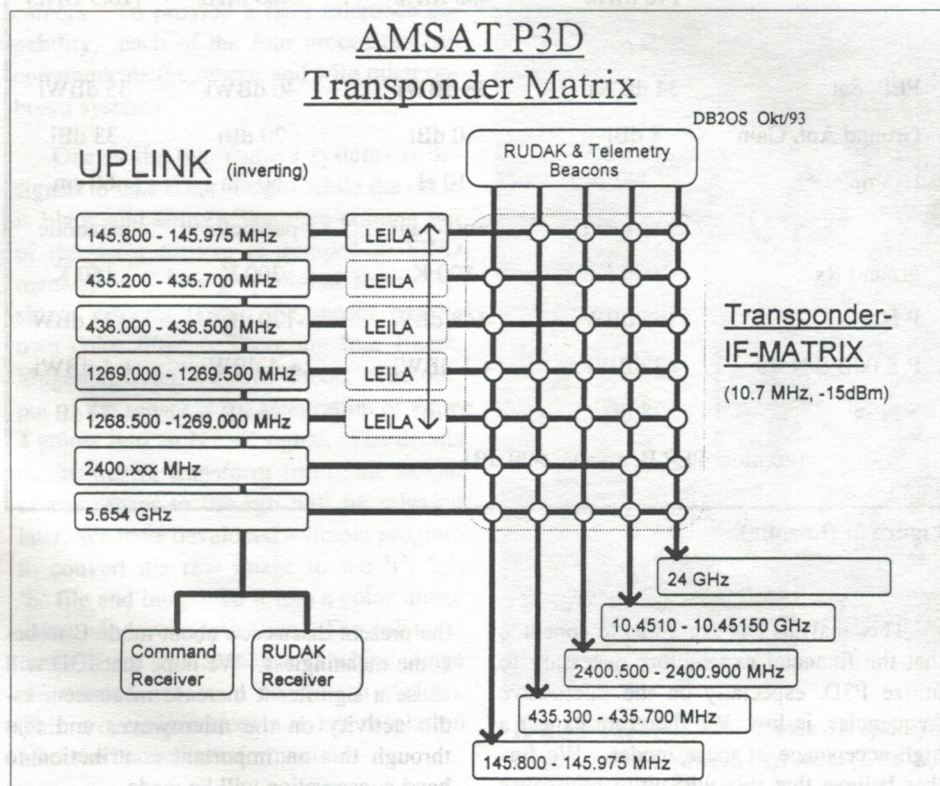


Figure 1 - Transponder Matrix for P3D

were always implemented, in order to offer both a popular "simple" system but also an ambitious transponder with better performance. So the evolution from mode A continued through mode B to mode L. In OSCAR 13 also mode S has met high acceptance. The principal reasons for this are that the VHF frequencies (and to some extent the UHF frequencies as well) are overcrowded and that there is now equipment for 1260 MHz and 2400 MHz available on the market.

We therefore expect that with P3D there will be significant operational time in these bands and that 10.5 GHz will also be a "forthcoming" band due to the possible use of low-priced TV technology.

Because the transponder will allow simultaneous use by a large number of stations, it is important to know how much of the transponder power will be typically available for the single user. In the past the AMSAT-DL has developed detailed models for this, which have proved accurate in practice. However, even without exact calculation one can easily estimate which links are "good". Transponders which produce PEP power on the ground of 30 dB or more of S/N in an SSB receiver work well in the amateur radio service.

The reason for this is that the average power of the transponder has to be 6 dB under the PEP value due to linearity reasons. Estimating 50 users, the average power of the single user will be -23 dB under PEP. Furthermore the typical SSB user has a ratio of 13 dB (inclusive of speech breaks) between average value and peak, so that the PEP value of the single user is around -10 dB under the PEP of the transponder. This means at 30 dB S/N PEP from the transponder, the single user will have 20 dB S/N PEP, which has been shown to work well in practice.

Figure 2 shows the ground power which is required for 23 dB S/N. You will see that beam antennas are not required for the operation on 2 m and 70 cm, if 50 W PEP EIRP can be achieved. Only modest transmission power and 60 cm antennas will do it on all micro-wave bands.

	146 MHz	435 MHz	1260 MHz	2400 MHz	(10,5 GHz)
T N (K)	1000	500	300	300	300
P Rx (23dB)	-142 dBW	-145 dBW	-147 dBW	-147 dBW	-147dBW
Sat Ant Gain	10 dBi	14 dBi	20 dBi	20 dBi	20 dBi
d (ii)	170 dB	179 dB	188 dB	194 dB	207 dB
ground-PEP	18 dBWi	20 dBWi	21 dBWi	27 dBWi	40 dBWi
Example:	10 W+	10 W+	5 W+	5 W +	3 W +
	7 el	10 el	Short	60 cm	60 cm
	cross-yagi	cross-yagi	Backfire	parabolic	parabolic
	or 50 W+	or 50 W+	(40 cm	antenna	antenna
	3 dBi	3 dBi	diameter)		

Figure 2: Uplink

Figure 3 shows the relationship for the satellite ground link. It can be seen that the signal-to-background ratios are remarkably larger than the required 20 dB with the configurations selected. This means that mo-

bile service is possible without problems. Antennas that are smaller than 60 cm will do it on the microwave frequencies. 2400 MHz will be the "best" band.

	146 MHz	435 MHz	2400 MHz	(10,5 GHz)
PEP Sat	34 dBWi	38 dBWi	40 dBWi	35 dBWi
Ground Ant. Gain	8 dBi	10 dBi	20 dBi	33 dBi
Example:	7 el	10 el	60 cm	60 cm
	cross-yagi	cross-yagi	parabolic	parabolic
ground Rx	1000 K	500 K	300 K	150 K
P N	-165 dBW	-168 dBW	-170 dBW	-173 dBW
P S 0dB S/N	- 3 dBWi	+ 1 dBWi	+ 4 dBWi	+ 1 dBWi
S/N ->	28 dB	27 dB	26 dB	24 dB
(nominal PEP Ben value >20 dB)				

Figure 3: Downlink

This analysis has caused us to conclude that the financial expenditure necessary to utilize P3D, especially on the microwave frequencies, is low. We therefore expect a high acceptance of these modes. We further believe that this will ultimately cause

the present discussion about mode B to become meaningless. We hope that P3D will cause a significant increase in amateur radio activity on the microwaves and that through this an important contribution to band conservation will be made.

KITSAT-2 Imaging system

by Sang-Keun Yoo, SaTRec

SaTReC has been developed as a new experimental space sensor using commercial color matrix detector by cooperative joint work with Samsung, one of the leading companies in Korea.

The new color camera was developed for the following purposes:

- Field test of the commercial detector and peripherals in space.
- Gather experience in color imaging from space.
- Demonstrate our capability of developing new systems.

The KITSAT-2 system differs substantially from that contained in KITSAT-1. The new imaging system includes two complete camera chains including a transputer, a microcontroller, and a camera head.

The Transputer Image Processing Board has four microprocessors T0, T1, M0, M1. The T1 and T0 are identical, and quite similar to the T1 of KITSAT-1 with different memory and memory configurations. The M0 however is newly developed for new camera. To provide a fault tolerance capability, each of the four processors can communicate the others, and with other on-board systems.

One of the two camera systems is designed to take color images while the other is black and white. The data coming out of the color camera is dumped to FIFO memory in 8 bits grey digital form. The single detector within the sensor has its own color filter. There are four filters: Magenta, Cyan, Yellow, Green. The output of the sensor is the integration of these 4 colors into an NTSC signal. The details of the matrix transform from the output of the sensor to the rgb will be released later. We have developed a simple program to convert the raw image to the 'r', 'g', 'b' file and integrated it into a color image using windows application. The enhancement of the color/black and white image are carried out on a Macintosh (Q800). This process produces a 4 km resolution after the matrix transformation.

The black and white system is similar to that contained on KITSAT-1. It has a ground resolution of 200 meters.



Figure 1: Image of Solmolia taken from KITSAT-2.

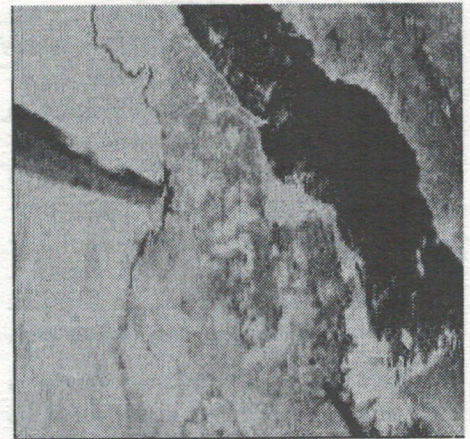
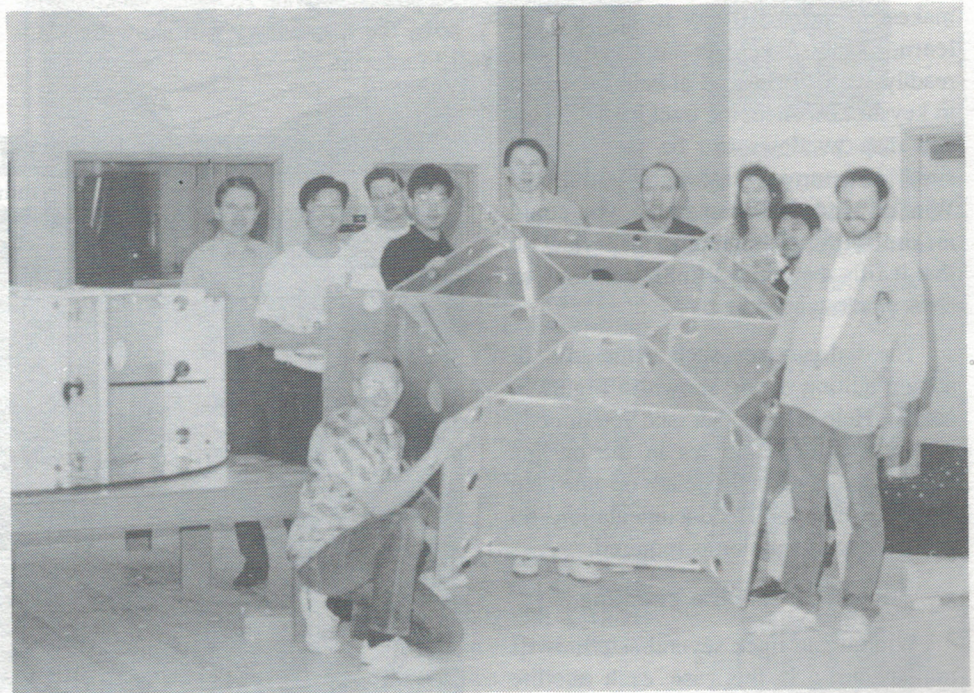


Figure 2: Image of the Red Sea taken from KITSAT-2.

ed. note: Figures 1 and 2 show pictures taken by KITSAT of Somalia and the Red Sea. These images are visually stunning when rendered in color. They

are in JPG format and can be viewed by any one of a number of programs including LVIEW31.EXE (referenced in the last issue of *The AMSAT Journal*.--



Is it big enough? The Phase 3D spaceframe and the Weber State University construction team. Dave Sudweeks (front), (L to R) Kelly Howard (faculty adviser), Wynn Khong, Devin Foster, Chun Yu Lin, Jay Packer, Jaim Parsons (Student Project Leader), Julie Williams, Sombat Jouynoun, and Troy Blandell.

WinSat Version 1.0: New Windows-Based Satellite Tracking Software

by Mike Mraz, N6MZ

WinSat is a new satellite tracking program for the Microsoft Windows operating environment. WinSat displays calculated satellite orbital data and other information, such as azimuth and elevation, in a text window. This information is updated once per second. WinSat also shows the satellite location on two dynamically-updated map views, a standard orthographic map and a 3-D map. Figure 1 shows the WinSat display, as it tracks AO-13 from the Seattle, Washington area.

WinSat is a well behaved Windows application, which means that it yields the computers CPU frequently enough that other running applications can multitask, and that it uses standard Windows user-interface guidelines.

User Interface

WinSat's interface should look familiar to anyone who has used other Windows programs. All of WinSat's user-interface functions are contained in drop-down menus and dialog boxes. This makes the program easy to explore and learn, because all the commands are readily available instead of being assigned to keystrokes. Also, the tracking windows and map windows can be sized as desired, and moved anywhere within the WinSat window. For example, you could maximize the orthographic map view so that it fills the entire WinSat window, as shown below.

The dialog boxes, such as the ground-station editing dialog shown in Figure 3, contain Help buttons that take you directly to the appropriate topics in the on-line help system. In fact, WinSat's on-line help system is the products documentation--no printed documentation is required.

Multiple Satellite Tracking

WinSat can track several satellites simultaneously. In this case, each satellite has its own tracking window. The two map views are updated to reflect the location of the satellite in the active Tracking window. For example, you can track

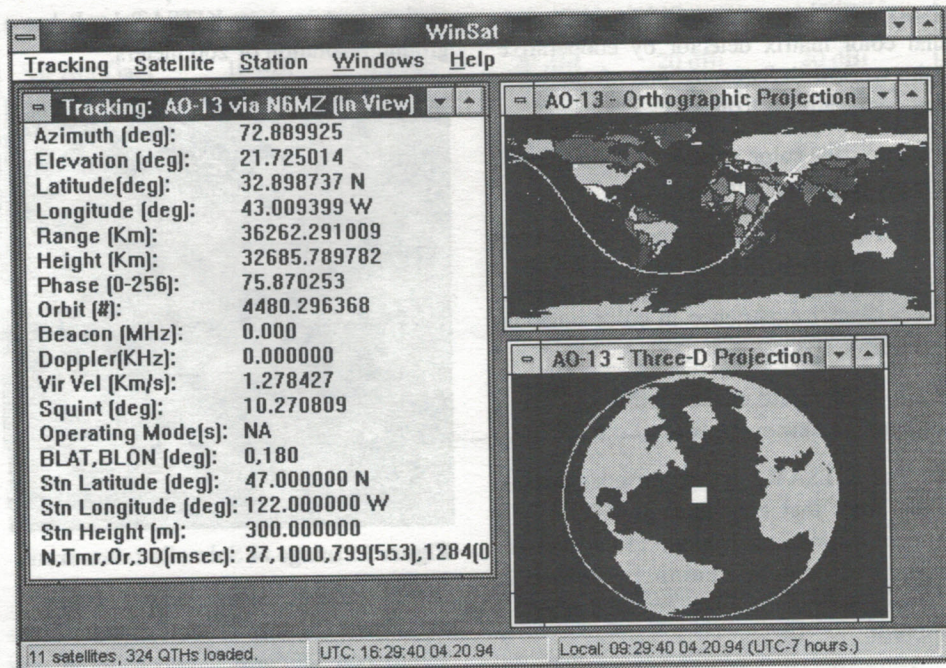


Figure 1 WinSat tracking AO-13

AO-13 and RS-12 simultaneously. When you activate RS-12s Tracking window, the map views will show the RS-12 footprint. When you activate AO-13s Tracking window, the map views will show the AO-13 footprint.

Customizing the Databases

The satellite database contains orbital elements and other important data (such as transponder schedule and antenna orientation). You can modify the database manually, using one of WinSat's menu commands, or you can update orbital elements from a NASA-standard or

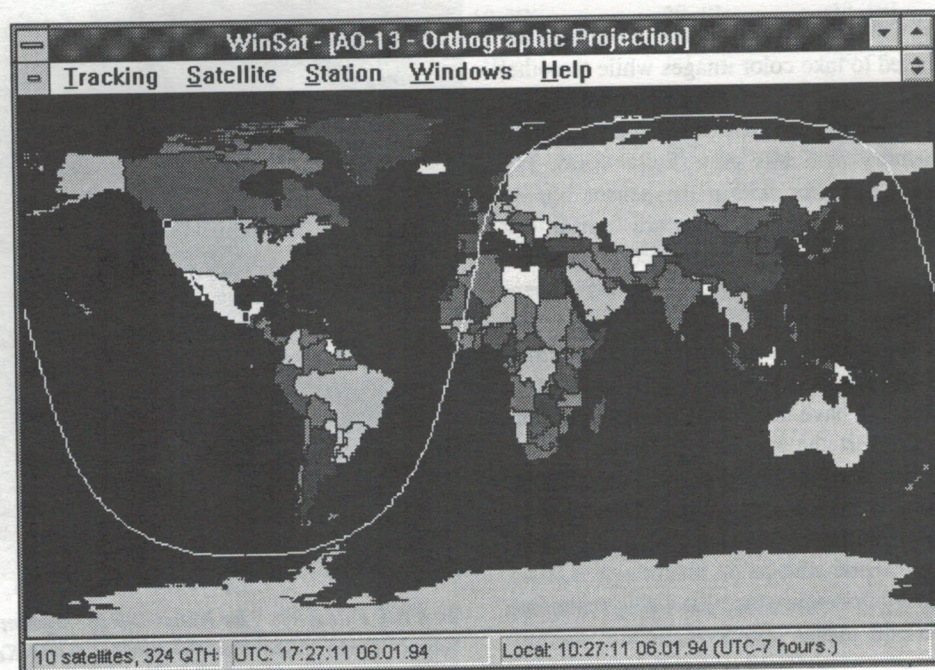


Figure 2 Orthographic map window maximized; WinSat tracking AO-13

AMSAT-standard elements text file. The satellite database can store orbital elements for over 100 birds.

The ground station database that is shipped with WinSat contains data for all current DXCC countries. You can add a custom entry for your home QTH from a menu command. You can also change existing entries or delete entries in the ground station database.

System Recommendations

WinSat is designed to run under the Windows environment on higher-performance personal computers such as those containing a 386 with math coprocessor, 486, or Pentium. The computer should also contain at least 4Mbytes of RAM. If you own a PC with a lower-performance processor such as a 286 or a 386 without coprocessor, then you should consider one of the MS-DOS tracking programs such as InstantTrack.

Ordering WinSat

WinSat is available now from AMSAT-NA. The price is \$30 for members and \$50 for non-members. Significant upgrades (including ephemeris calculations and KCTracker support) are expected in the near future. Upgrades will be available at substantial discounts to registered owners of version 1.0. To order, contact Martha, AMSAT-NA, 850 Sligo Avenue Suite 600, Silver Spring, Maryland 20910, or call (301) 589-6062. WinSat will soon be available in Europe and in the UK.

Upcoming Features

These feature additions are being designed for the next release of WinSat:

Support for the Kansas City Tracker board

Mutual visibility predictions between two ground stations via a satellite

Orbital predictions (ephemeris) for a ground station/satellite combination

Support for the AEA ST-1 tracker

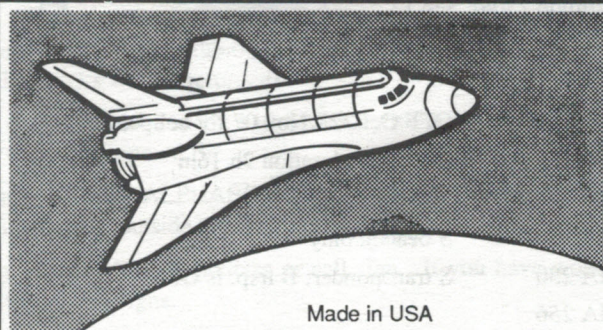
Program suggestions, feature requests, and bug reports are always welcome. Contact Martha at AMSAT-NA headquarters (see previous address) or contact the program author, Joe Holman, KA7LDN, P.O. Box 73, Redmond, Washington 98073.

WinSat - Change a Tracking Station's QTH Information.

Callsign:	N6MZ	
Latitude(0-90 N S):	47.000000 N	OK
Longitude(0-180 W E):	122.000000 W	Cancel
Height(m):	300	Delete
		Help

Figure 3 Typical WinSat dialog box

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AMSAT News

AO-13 Schedule released for May-Nov, 1994

1994 May 07-Jul 11

Mode-B : MA 0 to MA 170
Mode-BS: MA 170 to MA 218
Mode-S : MA 218 to MA 220 S beacon only
Mode-S : MA 220 to MA 230 S transponder; B trsp. is OFF
Mode-BS: MA 230 to MA 250
Mode-B : MA 250 to MA 256
Omnis : MA 250 to MA 120
Alon/Alat 230/-5; Move to attitude 180/0, Jul 11.

1994 Jul 11 - Sep 12

Mode-B : MA 0 to MA 90
Mode-BS: MA 90 to MA 120
Mode-S : MA 120 to MA 122 S beacon only
Mode-S : MA 122 to MA 145 S transponder; B trsp. is OFF
Mode-S : MA 145 to MA 150 S beacon only
Mode-BS: MA 150 to MA 180
Mode-B : MA 180 to MA 256
Omnis : MA 230 to MA 30
Alon/Alat 180/0; Move to attitude 230/0, Sep 12.

1994 Sep 12 - Dec 19

Mode-B : MA 0 to MA 150 OFF Oct 22 - Nov 07 for eclipses
Mode-B : MA 150 to MA 190 max duration 2h 16m
Mode-BS: MA 190 to MA 218
Mode-S : MA 218 to MA 220 S beacon only
Mode-S : MA 220 to MA 230 S transponder; B trsp. is OFF
Mode-B : MA 230 to MA 256
Omnis : MA 250 to MA 140
Alon/Alat 230/0; Move to attitude 180/0, Dec 19.

Please don't rely on gossip and rumor. Continuous up-to-date information about AO-13 operations is always available on the beacons, 145.812 MHz or 2400.664 MHz in CW, RTTY and 400 bps PSK. These bulletins are also posted to Internet, ANS, Packet, PacSats etc, and many international newsletters. A 400 bps PSK decoder is available from G3RUH and several DSP products; display software P3C.EXE etc from many AMSAT groups. The active command stations are listed below, and constructive feedback about operations is always welcome.

Peter DB2OS @ DB0FAU.#NDS.DEU.EU

James G3RUH @ GB7DDX.#22.GBR.EU

Graham VK5AGR @ VK5WI.#ADL.#SA.AUS.OC

The above may also be reached via Internet (callsign@amsat.org) and KO-23. Please remember to state clearly a return address. Notes prepared on behalf of, and in total cooperation with the above by:

James Miller G3RUH @ GB7DDX.#22.GBR.EU

Goddard Amateur Radio Club Opens Server on Internet

The NASA Goddard Amateur Radio Club, Inc. in Greenbelt, Md. has been working behind the scenes on projects that may benefit all amateur radio operators in general and perhaps AMSAT members in particular.

Ron Parise WA4SIR has been beta testing a BBS which is accessible via the Internet through telnet and ftp, telephone modem, and packet radio (locally on 145.090 MHz and nonlocally through "packet wormholes"). With Ron's heavy STS-67 crew training as of late, Jim Blackwell N3KWU is picking up much of the work to complete the beta phase. The BBS contains Keplerian orbital elements updated daily, AMSAT bulletins, SAREX bulletins, club member mail service, club announcements, space shuttle mission info and lots more. Access via Internet is available at wa3nan.gsfc.nasa.gov or 128.183.105.17. The bbs can also be dialed up at: 301-286-4137.

Additionally, the Goddard Amateur Radio Club has a home page for public viewing on the GARC World Wide Web server. It contains the latest GARC Newsletter in electronic form, latest space shuttle keps, GARC calendar of events, details of upcoming club activities, current WA3NAN QSL card, club facility-repeater-BBS info, a Morse code experiment and more. World Wide Web URL is <http://macgwy-mac2.gsfc.nasa.gov/garc/wa3nan-home-page.html>

The GARC Web server was developed and is maintained by club president Jim Blackwell N3KWU (n3kwu@amsat.org). You are invited to check out its potential. This medium is the hottest item on the Internet today. Submitted by Pat, WD8LAQ (wd8laq@amsat.org).

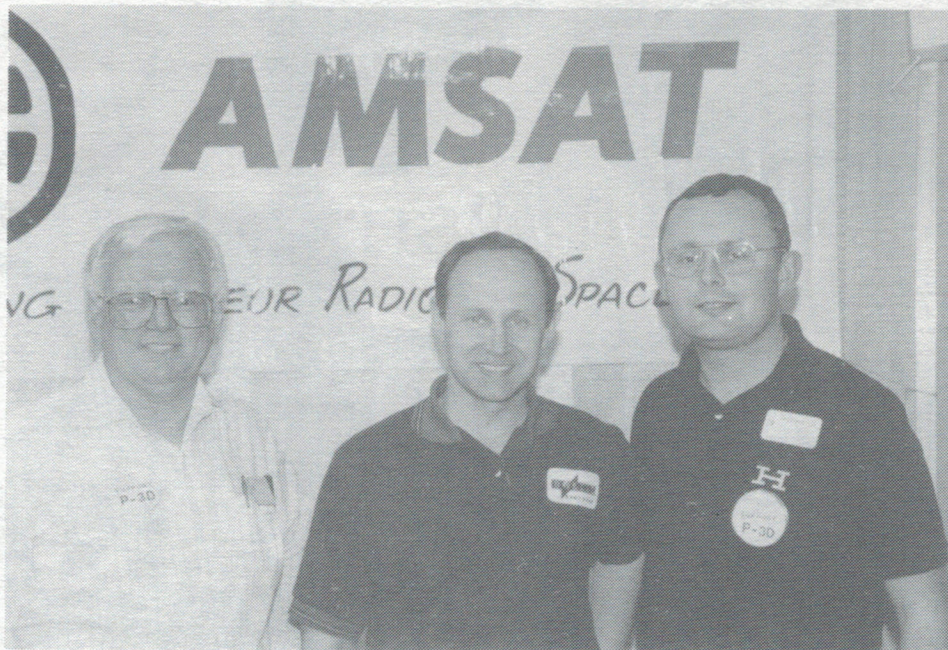
U7MIR Drops in at AMSAT in Miami

Cosmonaut Anatoli P. Artsebski, U7MIR dropped in at the AMSAT booth at the Miami Hamboree this past February. Anatoli was familiar with AMSAT and the OSCAR satellite program. He was primarily interested in software tracking programs that would show when amateur satellites were in radio view of the MIR space station. A secondary requirement was the abil-

ity to calculate when the Space Shuttle would pass close enough for cosmonaut to astronaut communication.

After lengthy discussions with Barry Baines, WD4ASW and John Kuklinski, N4PLY about the satellite packet equipment and software on display at the AMSAT booth, he expressed interest in the Phase 3D satellite model constructed by Stan Wood, WA4NFY, and Dick Jansson, WD4FAB which was on display. With that cue, Barry invited him to attend the AMSAT Phase 3D update talk scheduled later that afternoon and speak about his experiences on board MIR. Anatoli graciously agreed, and was the hit of the forum as he related how Amateur Radio communication fit into activities on board and what he felt was the next step in the upgrade of the ham equipment.

In typical Ham fashion, Anatoli visited many of the exhibitors and was last seen heading across the hamfest floor with an armload of 'goodies'.



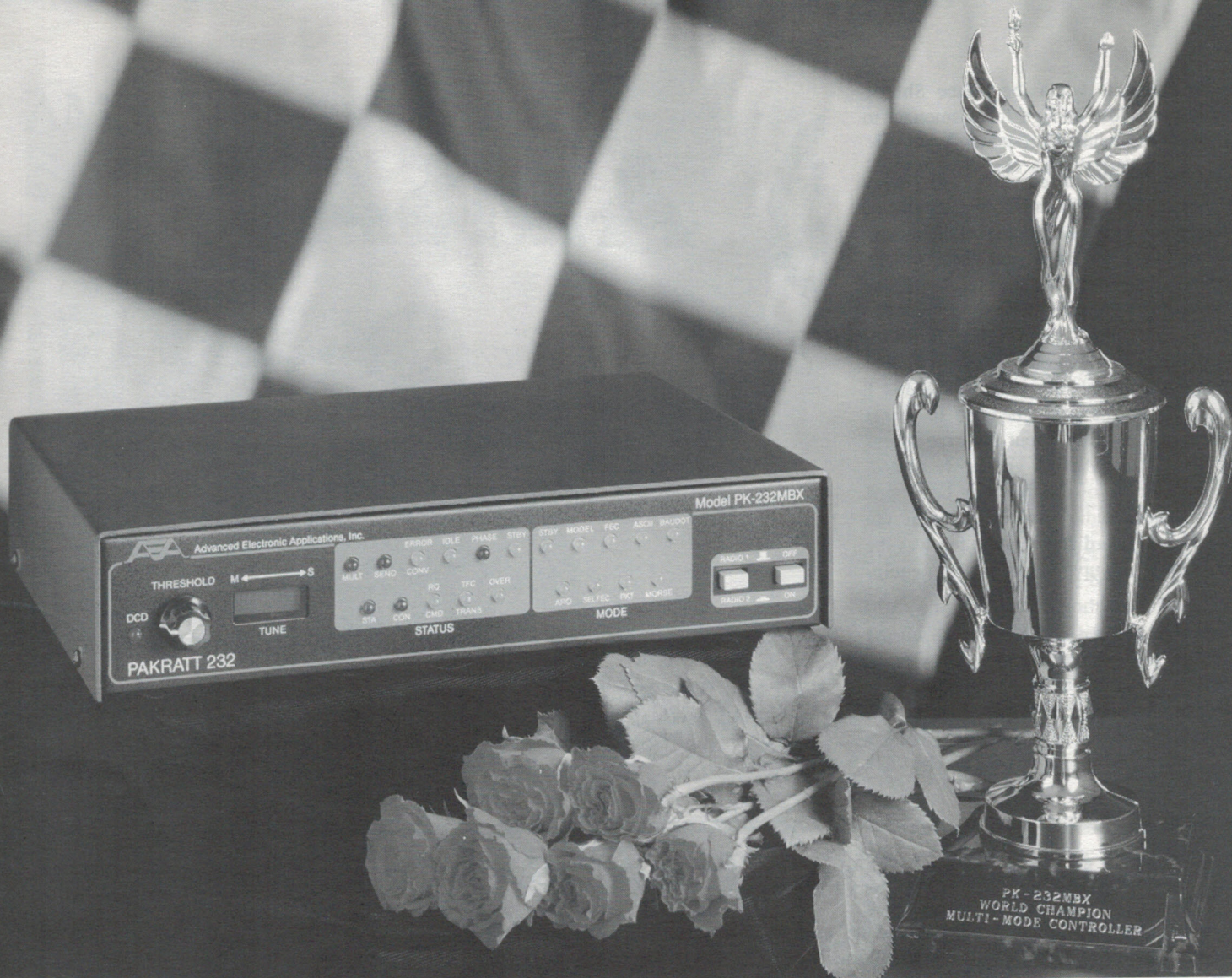
Hank Fitz, WB4URU, Anatoli Artsebaski, U7MIR, and Barry Baines, WD4ASW at the AMSAT booth at the Miami Hamboree.

Rules For Using The AMSAT QSL Bureau

1. The AMSAT QSL Bureau serves the users of all amateur radio satellites with a complete QSL Bureau for all amateur radio satellite contacts (QSL's other than satellite QSO's will be returned).
2. Stations wanting to use the Bureau need only send three to six #10 SASE's with their call in the upper left hand corner. DX stations should include enough IRC's for each envelope on file.
3. To send cards through the Bureau, arrange the cards ALPHABETICALLY by call sign. Stateside cards are free. However, there is a charge of 10 cents per card for all stations outside the U.S. Postal districts.
4. Always keep the Bureau informed of any changes in your address or call sign. If you have worked stations with more than one call sign, you should send envelopes for all call signs.
5. Mailings from the Bureau will be at the end of each month. All envelopes with ANY cards will be mailed at this time. The only exception is if the amateur would like to have their envelope held for a certain number of cards before being mailed. This can be done by writing just below your call sign (in the upper left-hand corner) the number of cards desired in the envelope before it is mailed.
6. QSL cards that are received at the Bureau when there are no envelopes on file will be held and the Bureau will make an effort to notify the user that he/she has cards on file. If no envelopes are sent to the Bureau within a period of 6 months, the cards will be DESTROYED!
7. Mailings for DX stations and individual international QSL Bureaus will go out at the end of the month.
8. OSCAR users should also keep envelopes on file at the appropriate ARRL QSL Bureau because most DX cards come to them.
9. Questions about the AMSAT OSCAR QSL Bureau should be sent with an SASE to the Bureau Manager:

AMSAT QSL Bureau
3702 Allison Street
Brentwood, Maryland 20722

The Bureau Manager, Walt Rader, WA3DMF, informs us that there are currently about 1500 amateurs with cards, but no envelopes at the Bureau. Please send yours in!



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